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2024년 4월 제33권 1호



사단법인 한국우주과학회
The Korean Space Science Society

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<사단법인 한국우주과학회 입회 안내>

사단법인 한국우주과학회는 천문·우주과학 및 관련분야에 종사하는 여러분의 입회를 환영합니다. 우리 학회에 입회를 희망하시는 분은 입회원서 양식에 인적사항을 기재하시어 학회로 보내주시거나 홈페이지에서 가입하시고 입회비와 연회비는 학회 은행계좌로 송금하시기 바랍니다.

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▣ 회비납부안내

회원구분	입회비	연회비
학생회원(학부생)	10,000원	10,000원
정회원	10,000원	70,000원
회장, 부회장	-	150,000원
이사, 감사	-	150,000원

※ 회원의 구분은 정관 제6조에 의거하며, 변경된 연회비는 학회운영에 대한 규정 제2조에 의거한 사항입니다.

※ 뒷면의 입회원서를 복사하여 사용해 주십시오.

[표지사진 설명]

2024년 7월 13일부터 21일까지 부산 벡스코에서 개최되는 COSPAR 2024는 세계적인 우주 연구 분야의 발전을 위한 국제 협력과 정보 교류의 장을 제공합니다. COSPAR 2024에는 약 60여 개국에서 3,000명 이상의 참가자가 예상되며, 국내 연구 성과를 세계에 알리는 중요한 기회가 될 것입니다. 뿐만 아니라, COSPAR 2024는 우주항공청의 설립 해의 학술 총회로 중요한 도약의 시작입니다. 다가오는 COSPAR 2024 많은 관심 부탁드립니다.

입 회 원 서

<table>
<tr><td>성 명</td><td colspan="2">한글
영문</td><td>성 별</td><td>남/여</td><td>생 년 월 일</td><td colspan="2">년 월 일</td></tr>
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<tr><td>학사</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
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<tr><td>박사</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>분과회
선택</td><td colspan="7">- 중복선택 가능
☐ 태양우주환경분과 ☐ 우주탐사분과 ☐ 우주관측기기분과
☐ 우주감시분과 ☐ 초소형위성분과 ☐ 활동 안함</td></tr>
<tr><td>경 력</td><td colspan="7"></td></tr>
<tr><td>연구 업적</td><td colspan="7"></td></tr>
</table>

위 본인은 귀 학회의 설립 목적과 취지에 찬동하여 이에 회원 가입을 신청합니다.

년 월 일

신청인: (인)

위 사람을 귀 학회의 회원으로 추천합니다(참고: 정관 7조 1항에 따라 추천인은 우리 학회 정회원이면 누구나 가능합니다).

추천인 : 직장 및 직위	성명	(인)
추천인 : 직장 및 직위	성명	(인)

사단법인 한국우주과학회 귀중

한국우주과학회 2024년 봄 학술대회 및 창립 40주년 기념행사

일　　시 : 2024. 4. 24.(수) ~ 26.(금)

장　　소 : 라한셀렉트 경주

포스터 집중 발표 : 2024. 4. 25.(목)　14:50~16:20

후　　원 : KOFST 한국과학기술단체총연합회　대한민국육군 Republic of Korea Army

ktl 한국산업기술시험원 Korea Testing Laboratory

등록 및 안내

1. 등록

회원의 등록비는 일반 정회원은 270,000원, 대학원생 정회원은 200,000원, 학생부과 군경은 150,000원입니다. 사전등록을 하신 회원은 학회보, 명찰을 수령하시기 바랍니다. 등록비 영수증과 참가확인증은 홈페이지에서 발행 가능합니다.

2. 발표자료 준비

구두발표: 발표자료는 파워포인트 파일로 준비하시기 바랍니다. 위촉된 심사위원이 우수 구두발표를 선정하여 폐회식 때 시상을 합니다(세션별 좌장이 심사하지 않음).

포스터발표: 포스터 발표는 A0 사이즈 1장(A0 사이즈 1장 내에 들어갈 분량, 예를 들면 A3 8장) 크기이며, 4월 25일(수) 13시까지 지정된 장소에 게시하고, 27일(금) 10시까지 수거해 주시기 바랍니다. 집중발표 시간에 발표자는 자신의 포스터 앞에서 회원들의 질문에 답할 수 있도록 준비해 주시기 바랍니다. 위촉된 심사위원이 우수 포스터발표를 선정하여 폐회식 때 시상을 합니다. 포스터를 부착하지 않거나 학회 종료 후 수거하지 않은 회원은 추후 학회발표가 제한될 수 있습니다.

3. 발표장

Convention A	Convention B	Convention C	Vega Hall	Lobby	Capella Hall
- Invited Talk - 태양 및 우주환경 I, II, III, Ⅳ - 위성정보활용 - SS: 태양광회절 추진 우주항해	- 우주인프라 - 우주탐사 I, II - 우주천문 - 우주산업 - SS: 학부생 세션	- 초소형위성 - SS: L4 관측기기 I, II, III, Ⅳ	- 안보우주 I, II, III - 우주감시	전시부스 & 포스터발표	아이돌봄

4. 교통 안내

가. 주소: 경상북도 경주시 보문로 338 라한 셀렉트(Tel: 054-748-2233)

나. 찾아오시는 길

▶KTX 이용시: 신경주역
- 택시: 35분 내외, 약 25,000원
- 버스: 700, 710(1시간 내외)

▶무궁화호 이용시: 경주역
- 택시: 20분 내외, 약 9,600원
- 버스: 경주우체국 정류장에서
  10, 16, 18, 100-1, 150-1, 700(30분 내외)

5. 구두발표 색인표

Ⅰ - 1 - 1

세션번호 발표장 발표순서

6. 학회보 다운로드

2024 KSSS SPRING CONFERENCE PROGRAM

Apr. 24. (Wed)

Time	Functions
12:00~	**Registration: Lobby**
13:30~13:50	**Opening Ceremony: Convention A** 환영사: 박종욱 회장 / 축사: 이재형(우주청 추진 단장)
13:50~14:30	**Invited Talk** **Room: Convention A** Chair: 조경석(천문연) John Lee (Retired NASA Senior Executive) NASA Organization and the Roles of Program Scientists and Program Executives.
14:30~14:40	휴식(Break Time)
14:40~16:10	**정책포럼 I** **Room: Convention A** 진행: 권윤영(천문연) 주제: 우주항공청 체제에서 우주과학의 역할
16:10~16:20	휴식(Break Time)

Room	Convention A		Convention B		Convention C		Vega Hall	
Session I	**태양 및 우주환경 I** 좌장: 박성홍(천문연)		**우주인프라** 좌장: 서행자(항우연)		**초소형위성** 좌장: 송영주(항우연)		**안보우주 I** 좌장: 최호성(육군)	
16:20~16:35	I-1-1	김연한	I-2-1	박영준	I-3-1	이명규	I-4-1	김한석
16:35~16:50	I-1-2	남욱원	I-2-2	백현철	I-3-2	이민태	I-4-2	송준원
16:50~17:05	I-1-3	이우경	I-2-3	양희수	I-3-3	문신혜	I-4-3	이우석
17:05~17:20	I-1-4	박수환	I-2-4	오태석	I-3-4	최영완	I-4-4	정영준

Apr. 25. (Thu)

Time	Functions							
Room	Convention A		Convention B		Convention C		Vega Hall	
Session II	**태양 및 우주환경 II** 좌장: 권혁진(극지연)		**우주탐사 I** 좌장: 홍승범(항우연)		**SS: L4 관측기기 I** 좌장: 한정열(천문연)			
09:00~09:15	II-1-1	김관혁	II-2-1	김우진	II-3-1	김만석		
09:15~09:30	II-1-2	감호식	II-2-2	박현후				
09:30~09:45	II-1-3	Yukinaga Miyashita	II-2-3	김주형	II-3-2	조경석		
09:45~10:00	II-1-4	양희수	II-2-4	조우인	II-3-3	김화영		
10:00~10:15	II-1-5	김정헌	II-2-5	조은진	II-3-4	문용재		
10:15~10:30	II-1-6	김보경	II-2-6	Lasany Arfin Kunja	II-3-5	임은경		
10:30~10:40	휴식(Break Time)							
Session III	**태양 및 우주환경 III** 좌장: 김수진(천문연)		**우주탐사 II / 우주천문** 좌장: 조은진(충남대)		**SS: L4 관측기기 II** 좌장: 문용재(경희대)		**안보우주 II** 좌장: 유지희(ADD)	
10:40~10:55	III-1-1	정종일	III-2-1	윤용식	III-3-1	이형권	III-4-1	최호성
10:55~11:10	III-1-2	권혁진	III-2-2	최기혁	III-3-2	박성홍	III-4-2	정종균
11:10~11:25	III-1-3	유지현	III-2-3	김푸름	III-3-3	김록순	III-4-3	김덕수
11:25~11:40	III-1-4	홍준석	III-2-4	Ulkar Karimova	III-3-4	복민갑	III-4-4	고종완
11:40~11:55	III-1-5	이해인	III-2-5	민병희	III-3-5	김건희	III-4-5	이병선
11:55~12:10	III-1-6	Hoang Nguyen	III-2-6	김상혁			III-4-6	박재흥
12:10~13:30	점심(Lunch)							
Session IV	**태양 및 우주환경 IV / 위성정보활용** 좌장: 홍준석(천문연)		**우주산업** 좌장: 한우제(KTL)		**SS: L4 관측기기 III** 좌장: 김록순(천문연)		**안보우주 III** 좌장: 최호성(육군)	
13:30~13:45	IV-1-1	지건화	IV-2-1	서대반	IV-3-1	이대영	IV-4-1	유지희
13:45~14:00	IV-1-2	정세헌	IV-2-2	조영준	IV-3-2	서정준	IV-4-2	양태용
14:00~14:15	IV-1-3	전웅	IV-2-3	김현준	IV-3-3	박재흥	IV-4-3	강원석
14:15~14:30	IV-1-4	이종길	IV-2-4	박봉규	IV-3-4	설우형	IV-4-4	박재필
14:30~14:45	IV-1-5	손동효			IV-3-5	손종대		
14:45~14:50	휴식(Break Time)							
14:50~16:20	**포스터 집중발표(Poster Session)**							
16:20~17:50	**정책포럼 II** **Room: Vega Hall** 진행: 김주현(항우연) 주제: 우주탐사와 우주개발 정책 발표자: 안형준(STEPI), 김민선(천문연), 류동영(항우연), 권윤영(천문연)							
17:50~18:00	휴식(Break Time)							
18:00~20:30	**만찬 & 창립 40주년 기념행사: Convention**							

Apr. 26. (Fri)

Time	Functions							
09:00~10:30	**특별세션** Room: Convention A 진행: 김은혁(항우연) 대한민국 달궤도선(다누리) 과학자료 공개							
10:30~10:40	휴식(Break Time)							
Room	Convention A		Convention B		Convention C		Vega Hall	
Session V	**SS: 태양광회절 추진 우주항해** 좌장: 전현진(항우연)		**SS: 학부생 세션** 좌장: 정종균(천문연)		**SS: L4 관측기기 IV** 좌장: 이대영(충북대)		**우주감시** 좌장: 최 진(천문연)	
10:40~10:55	V-1-1	임현수	V-2-1	김채윤	V-3-1	이승욱	V-4-1	최은정
10:55~11:10	V-1-2	전현진	V-2-2	전세린	V-3-2	진호	V-4-2	이희재
11:10~11:25	V-1-3	문상만	V-2-3	강민욱	V-3-3	유광선	V-4-3	최 진
11:25~11:40	V-1-4	김인규	V-2-4	이승예	V-3-4	Enno B Starossk	V-4-4	성기평
11:40~11:55	V-1-5	김민기	V-2-5	이정현	V-3-5	Thiem Hoang		
11:55~12:10			V-2-6	김하나				
12:10~13:00	**Closing Ceremony: Convention A** **우수 구두발표상, 우수 포스터상 시상식**							

Poster Session

4. 25. (Thu) 14:50~16:20

Area	No	Author	Affiliation	Area	No	Author	Affiliation
우주 인프라	P-1	양승은	항우연	우주 산업	P-28	이선호	항우연
	P-2	박성욱	항우연		P-29	조창권	항우연
	P-3	박수현	항우연		P-30	윤지연	항우연
	P-4	이충욱	천문연	우주 탐사	P-31	김동규	항우연
	P-5	강 철	항우연		P-32	이일섭	항우연
	P-6	백현철	항우연		P-33	송영주	항우연
	P-7	채동석	항우연		P-34	서기훈	항우연
	P-8	황기룡	항우연		P-35	김희경	항우연
	P-9	전종협	항우연		P-36	배종희	항우연
	P-10	현정훈	항우연		P-37	임조령	항우연
	P-11	박균상	항우연		P-38	김주현	항우연
	P-12	김혜원	항우연		P-39	원영진	항우연
우주 산업	P-13	한우제	KTL		P-40	장윤호	경희대
	P-14	김영윤	항우연		P-41	김연규	항우연
	P-15	연정흠	항우연		P-42	임정흠	항우연
	P-16	방수완	항우연		P-43	이승민	경희대
	P-17	김형완	항우연		P-44	김진형	항우연
	P-18	최정수	항우연		P-45	이종원	항우연
	P-19	박종석	항우연		P-46	장윤정	항우연
	P-20	박근주	항우연		P-47	백길호	경희대
	P-21	신현진	항우연	위성정보 활용	P-48	정대준	항우연
	P-22	박종억	항우연		P-49	박홍원	항우연
	P-23	김창호	항우연		P-50	김영선	항우연
	P-24	박성우	항우연		P-51	박종오	항우연
	P-25	이종태	항우연		P-52	김상구	항우연
	P-26	이수영	항우연		P-53	신재민	항우연
	P-27	강우용	항우연				

Poster Session

4. 25. (Thu) 14:50~16:20

Area	No	Author	Affiliation	Area	No	Author	Affiliation
초소형 위성	P-54	최재동	항우연	태양 및 우주환경	P-73	이호진	천문연
	P-55	김재규	(주)아이옵스		P-74	송동욱	천문연
	P-56	성재동	항우연		P-75	박진혜	경희대
	P-57	신현규	항우연		P-76	이승예	충남대
	P-58	김지석	항우연		P-77	이재욱	천문연
	P-59	김준현	조선대		P-78	나현옥	경희대
	P-60	오승준	조선대		P-79	김수진	천문연
	P-61	김진혁	항우연		P-80	김기범	한국항공대
	P-62	김채령	충남대		P-81	박준욱	충북대
태양 및 우주환경	P-63	최규철	(주)에스이랩	우주 정책	P-82	이서림	항우연
	P-64	오수연	전남대		P-83	박응식	항우연
	P-65	최지은	충남대		P-84	양지모	항우연
	P-66	백준호	경희대		P-85	신근웅	항우연
	P-67	장서희	충북대	우주 천문	P-86	최홍순	천문연
	P-68	곽재영	천문연		P-87	김신욱	항우연
	P-69	안준모	경희대	학부생 세션	P-88	홍승모	충남대
	P-70	박성홍	천문연	마이크로 중력 환경 활용	P-89	이주희	항우연
	P-71	권종우	극지연	안보 우주	P-90	송호섭	천문연
	P-72	조유진	극지연				

우주과학회 ’24 봄 학술대회 우주정책포럼

대한민국은 2045년 ‘5대 우주강국’ 도약을 목표로 하는 우주항공청 설립을 추진하고 있으며, 올해 5월 개청할 예정입니다. 한국우주과학회에서는 우주항공청 설립에 즈음하여 우주정책포럼을 개최합니다. ‘우주’라는 넓고 깊은 주제를 담아내기 위해 포럼은 1부와 2부로 나누어 진행합니다.

정책포럼 I. 우주항공청 체제에서 우주과학의 역할

- **일시/장소:** 4월 24일 수요일 14:40~16:10 / Convention A
- **진행:** 권윤영 한국천문연구원
- **패널:** 박재필 나라스페이스테크놀로지 대표
  신동윤 페리지에어로스페이스 대표
  안재명 한국과학기술원 항공우주공학과 교수
  이경숙 한국천문연구원 정책부장
  이주희 한국항공우주연구원 책임연구원

1부에서는 산 · 학 · 연 각기 다른 활동 분야에서 대한민국 우주 발전을 위해 오랜 동안 고민해 오신 전문가분들을 모시고, 참여하시는 모든 분들과 학회, 우주과학, 우주항공청, 대한민국 우주의 미래 모습을 구상하고 토론합니다. 토론 주제는 (1) 우주항공청과 우주강국의 우주과학, (2) 우주산업생태계의 씨앗 — 우주과학임무, (3) 우주인력 양성과 국제협력에서의 우주과학 등으로, 국가적인 현안과 미래 지향점을 담는 동시에, 우리 우주과학회의 미래 역할을 예측합니다.

정책포럼 II. 우주탐사와 우주개발 정책

- **일시/장소:** 4월 25일 목요일 16:20~17:50 / Vega Hall
- **진행:** 김주현 한국항공우주연구원
- **발제발표:** 안형준 국가우주정책연구센터
  김민선 한국천문연구원
  류동영 한국항공우주연구원
  권윤영 한국천문연구원

2부에서는 우주 정책, 과학, 탐사, 국제협력 전문가의 발제 발표와 참석자들과의 토론으로 이루어집니다. 토론 주제는 (1) 우주항공청의 우주탐사로드맵 수립을 위한 정책제안, (2) 지속 가능한 우주를 위한 우주임무 개발 체계, (3) 우주 선진국의 우주탐사 계획/전략과 우리의 대응/전략, (4) 상업적 우주탐사 및 우주자원 활용에 관한 국가계획의 국제법적 검토 등으로, 대한민국이 우주 추격국에서 선도국으로 도약하기 위한 우주탐사와 우주개발 정책을 담습니다.

대한민국 달궤도선(다누리) 과학자료 공개

다누리 달 궤도선은 2022년 8월 5일 미국 플로리다주 케이프 캐너버럴 우주군 시설의 우주발사대에서 Space-X사의 Falcon-9 발사체에 실려 성공적으로 발사되었다. 그 후 다누리는 매우 정밀하게 설계된 달 전이 궤적을 비행하며, 약 4.5개월 동안 총 약 6백만 킬로미터의 우주 비행을 진행하며, 달 임무 궤도에 2022년 12월 말에 도착하였다. 이 후 다누리는 약 1개월의 사전임무운영을 진행했고, 그 후 2023년 12월까지 발사 전 계획된 정상 임무를 수행하였다. 이 기간 동안 다누리는 탑재된 5기의 과학 탑재체(고해상도카메라 LUTI, 광시야편광카메라 PolCam, 달자기장측정기 KMAG, 감마선분광기 KGRS, 영구음영지역카메라 ShadowCam)을 이용하여 다양한 과학 자료를 확보하였다. 이제 달 궤도에서의 임무 착수 약 1년 후에 최초로 과학 자료를 처리하여 일반에 공개하게 되었다. 특별 세션에서는 과학 자료 공개 경과와 탑재체별 과학 자료의 특징 및 처리 내용 등을 학회 회원들에게 소개하여 다누리 생산 과학 자료가 십분 활용되기를 기대하고 있다. 현재 다누리는 2025년 말까지 임무 연장이 확정되었다. 그리고, 계속해서 매 3개월마다 처리된 자료를 공개할 예정이다. 세션에서는 과학 자료뿐만 아니라, 과학 자료 처리에 필수적인 ancillary 자료 제공 내용과 과학 자료 공개 서비스를 제공하고 있는 KARI Planetary Data System(KPDS)에 세부 사항에 대한 설명도 함께 진행될 예정이다.

구두발표 논문 제목 및 시간표

4월 24일(수)

제1발표장 (Convention A)

13:50 [IS]

NASA Organization and the Roles of Program Scientists and Program Executives

John Lee

Retired NASA Senior Executive

16:20 [I-1-1]

Development of a Diagnostic Coronagraph on the ISS: CODEX Progress Report

Yeon-Han Kim[1], Su-Chan Bong[1], Seonghwan Choi[1], Kyungsuk Cho[1,2], Jeffrey Newmark[3], Nat. Gopalswamy[3], KASI-NASA Coronagraph Team

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*NASA Goddard Space Flight Center, USA*

16:35 [I-1-2]

Observation of Low-Earth Orbit Space Radiation Environment in by LEO-DOS on Board NEXTSat-2

Uk-won Nam[1], Won-Kee Park[1], Jaeyoung Kwak[1,2], Jongdae Sohn[1], Bongkon Moon[1], Jaejin Lee[1], Young-Jun Choi[1], Sunghwan Kim[3], Hongjoo Kim[4], Sung-Joon Ye[2], Hongyoung Park[5], Taeseong Jang[5], Sukwon Youn[6]

16:50 [I-1-3]

KASI NRT Ionospheric Monitoring System Using GNSS network

Woo Kyoung Lee[1,2], Byung-Kyu Choi[1], Dong-Hyo Sohn[1], Sung-Moon Yoo[1], Kyoung-Min Roh[1], Juneseok Hong[1], Se Heon Jeong[1], Tae-Young Yang[1], Jaeheung Park[1,2], Jong-Kyun Chung[1], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

17:05 [I-1-4]

Flight Model Readiness of the Langmuir Probe of IAMMAP for CAS500-3 Satellite

Su-Hwan Park, Kwangsun Ryu, Seunguk Lee, Jimin Hong, Seong-og Park, Jinkyu Kim, Bonju Gu, Wonho Cha

Satellite Technology Research Center, KAIST

제2발표장 (Convention B)

16:20 [I-2-1]

Research on Remodeling of Old Telescopes with Unknown Optical Data

Young Jun Park[1,2], Elijah J. H. Kim[1,2], Yun-Young Choi[2,3], Soojong Pak[1,2], Ilhoon Kim[1]

[1]*SLLAB, INC.*
[2]*School of Space Research, Kyung Hee University*
[3]*Department of Astronomy and Space Science, Khung Hee University*

16:35 [I-2-2]

A Study on the Utilization of KREONET for Advanced Multi-Satellite Operation

Hyun-Chul Baek, Tae-Gun Son, Jae-Hyoung Park

Korea Aerospace Research Institute

16:50 [I-2-3]

Creative Astronomical Instrument Design and Observation: Development of a Small Spectrograph and Observation Using Drift Scanning Method

Heesu Yang, Jong-Kyun Chung

Korea Astronomy and Space Science Institute

17:05 [I-2-4]

Separation Test of a Low Earth Orbit Satellite

Tae Seok Oh, Hee-Kwang Eun, Jong-Hyub Jun, Chang-Rae Cho, Jin Park, Kyung-Won Kim

[1]*Korea Aerospace Research Institute*

제3발표장 (Convention C)

16:20 [I-3-1]

Development of Simulator for Energy Balance

Analysis of Nano-Satellite

Myung-Kyu Lee[1], Seul-Hyun Park[2]

[1]*Graduate School of Chosun University*
[2]*Department of Mechanical Engineering, Chosun University*

16:35 [I-3-2]

The Current Status and Re-Launch Readiness after Non-Deployment of JINJUSat-1

Mintae Lee[1,2], Hana Jung[1], Hongju So[1], Kyunghee Kim[1]

[1]*Space Testing Center, Korea Testing Laboratory*
[2]*Department of Aerospace Engineering, Gyeongsang National University*

16:50 [I-3-3]

Design and ETB Test Results of Attitude Maneuvering Profile Software (AMPS) for LEO Satellites

Shinhye Moon, Taeseog Kim, Jongjin Jang

Korea Aerospace Industries , Ltd.

17:05 [I-3-4]

Very High-Resolution Earth Observation in the New Space Era: Achieving 0.3-m GSD Images via Very Low Earth Orbit and Heterogeneous Constellations for Rapid Revisits

Youngwan Choi, Euichan Yoo, Hyoungseok Han, Bokyoung Kwon

CONTEC Space Optics (CSO)

제4발표장 (Vega Hall)

16:20 [I-4-1]

A Study on the Development of Low-Earth Satellite Cyber Security Policy in the Republic of Korea Army

Hanseok Kim, Byungjoon Jung

Republic of Korea Army

16:35 [I-4-2]

Orbit Design of Lunar Navigation Satellite System for Exploration of Lunar South Pole

JunWon Song[1], Hojoon Jeong[2], Minjae Kang[2,3], Jaeuk Park[2], JoonWang Lee[1], Changdon Kee[2]

[1]*Space/Science & Technology Division, Policy Office, ROKA HQ*
[2]*Department of Aerospace Engineering and the Institute of Advanced Machines and Design, Seoul National University*
[3]*Interdisciplinary Program in Space Systems, Seoul National University*

16:50 [I-4-3]

A Comparative Study on Space Launch Vehicle Authorization System for Security and Defense Purposes in Major Spacefaring Nations: Focusing on the United States, France and Japan

Woo-seok Lee

Korea National Defense University

17:05 [I-4-4]

Military Application Plan of A CubeSat Satellite for Republic of Korea Army

Young-Joon Jung, Ho-Sung Choi, Joon Wang Lee

Republic of Korea Army (ROKA)

4월 25일(목)

제1발표장 (Convention A)

09:00 [II-1-1]

Observation and Numerical Simulation of Cold Ions Energized by EMIC Waves

K.-K. Kim[1], C.-W. Jun[2], J.-W. Kwon[3], J. Lee[1], K. Shiokawa[2], Y. Miyoshi[2], E.-H, Kim[4], K. Min[5], J. Seough[6]

[1]*School of Space Research, Kyung Hee University*
[2]*Institute for Space-Earth Environmental Research, Nagoya University, Japan*
[3]*Korea Polar Research Institute*
[4]*Princeton Plasma Physics Laboratory, Princeton University, USA*
[5]*Department of Astronomy and Space Science, Chungnam National University*
[6]*Korea Astronomy and Space Science Institute*

09:15 [II-1-2]

Characteristics of Mesospheric Gravity Waves over the Korean Peninsula Analyzed by KASI Meteor Radar and TIMED/SABER Data

Hosik Kam[1], Young-Sil Kwak[1,2], In-Sun Song[3], Tae-Yong Yang[1], Byeong-Gwon Song[3], Jeongheon Kim[1], Jaewook Lee[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Yonsei University*

09:30 [II-1-3]

Simultaneous Occurrence of Substorm and Pseudosubstorm

Yukinaga Miyashita[1,2], Madeeha Talha[1,2,3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Karachi, Pakistan*

09:45 [II-1-4]

Observations of the Solar Corona during the 2024 Total Solar Eclipse

Heesu Yang, Suchan Bong, Young-Beom Jeon

Korea Astronomy and Space Science Institute

10:00 [II-1-5]

Preliminary Simulation Results for Ionospheric Responses during the April 8, 2024 Solar Eclipse

Jeong-Heon Kim[1], Young-Sil Kwak[1,2], Hosik Kam[1], Jaewook Lee[1,2], Tae-Yong Yang[1], Jongil Jung[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

10:15 [II-1-6]

Analysis of the Time-Distance Helioseismic Subsurface Flow for Active Region 13500

Bogyeong Kim[1], Sung-Hong Park[2], Yu Yi[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

10:40 [III-1-1]

Study on the Diurnal Variation of Cosmic Ray Intensity at Jang Bogo Neutron Monitor in Antarctica

Jongil Jung[1], Suyeon Oh[2], Young-Sil Kwak[1], Yu Yi[3], Geonhwa Jee[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chonnam National University*
[3]*Chungnam National University*
[4]*Korea Polar Research Institute*

10:55 [III-1-2]

Aurora Observations by Korean Automated Geophysical Observatoty (KAGO) at Cape Hallett, Antarctica

Hyuck-Jin Kwon[1], Changsup Lee[1,2], Geonhwa Jee[1,2], Young-Bae Ham[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

11:10 [III-1-3]

Investigating Energy Spectra of Energetic Electrons and Protons in Soalr Energetic Particle Events

Ji-Hyeon Yoo[1,2], Ryun-Young Kwon[1], Dae-Young Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungbuk National University*

11:25 [III-1-4]

Extreme Ionospheric GNSS Scintillation Events over Korean Peninsula on November 5, 2023

Junseok Hong[1], Byung-Kyu Choi[1], Jong-Kyun Chung[1], Woo Kyoung Lee[1], Hyosub Kil[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Johns Hopkins University Applied Physics Laboratory*

11:40 [III-1-5]

Diverging Destinies of Twin Solar Energetic Particle Events

Hae-In Lee[1,2], Ryun-Young Kwon[2]

[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*

11:55 [III-1-6]

A Study on the Occurrence Characteristics and Sources of Daytime Ionospheric Irregularities in the Mid and Low Latitudes of the East-Asia Region

Hoang Ngoc Huy Nguyen[1,2], Young-Sil Kwak[1,2], Woo Kyoung Lee[1,2], Hyosub Kil[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

[3]*Johns Hopkins University Applied Physics Laboratory*

13:30 [IV-1-1]

Assessment of Current Capabilities in Modeling the Ionospheric Climatology for Space Weather Applications: foF2 and hmF2

G. Jee[1,2], J. S. Shim[3,4], I.-S. Song[3], Y.-S. Kwak[2,5], I. Tsagouri[6], L. Goncharenko[7], L. Rastaetter[3], J. Yue[3], M. Chou[3], D. Blitza[8], M. Codrescu[9], M. Fedrizzi[9], T. J. Fuller-Rowell[9]

[1]*Korea Polar Research Institute (KOPRI)*
[2]*University of Science and Technology (UST)*
[3]*NASA, GSFC, Greenbelt, MD, USA*
[4]*Yonsei University*
[5]*Korea Astronomy and Space Science Institute (KASI)*
[6]*National Observatory of Athens, IAASARS, Penteli, Greece*
[7]*MIT, Haystack Observatory, MA, USA*
[8]*George Mason University, Fairfax, Virginia, USA*
[9]*NOAA SWPC, Boulder, Co, USA*

13:45 [IV-1-2]

Optimizing Deep Learning Models for Ionospheric TEC Prediction: Insights from Storm-to-Quiet Day Ratios

Se-Heon Jeong[1], Woo Kyoung Lee[1,2], Jeong-Heon Kim[1], Soojeong Jang[3], Hyosub Kil[4], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology (UST)*
[3]*Kyung Hee University*
[4]*Applied Physics Laboratory, Johns Hopkins University*

14:00 [IV-1-3]

Cross-Comparison of IGS TEC Using Jason TEC at the Continent-Ocean Boundary

Woong Jeon[1], Eun-Young Ji[2,] Yong-Jae Moon[1,2], Young-Sil Kwak[3]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*
[3]*Korea Astronomy and Space Science Institute*

14:15 [IV-1-4]

Comparative Analysis of Space Environment Data Extracted with GOLD Satellite Image Noise

Jonglil Lee[1], Jaeheung Park[2], Dae-Young Lee[1]

[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*

14:30 [IV-1-5]

Retrieval of Total Electron Content according to Vessel Movement in the Northwestern Pacific

Dong-Hyo Sohn[1], Byung-Kyu Choi[1], Junseok Hong[1], Yosup Park[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Institute of Ocean Science and Technology*

제2발표장 (Convention B)

09:00 [II-2-1]

Results of Space Environmental Tests for the GrainCams EQM Payload for a CLPS Lunar Rover

Woojin Kim[1,2], Bongkon Moon[1,2], Dukhang Lee[1], Dae-Hee Lee[1], Minbae Kim[1], Minsup Jeong[1], Jihun Kim[1,2], Sung-Joon Park[1], Yunjon Kim[1,2], Seonghwan Choi[1], Jehyuck Shin[1], Mingyeong Lee[1,2], Chae Kyung Sim[1,2], Young-Jun Choi[1,2], Sungsoo S. Kim[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Univesity of Science and Technology*
[3]*Kyung Hee University*

09:15 [II-2-2]

In-Flight Calibration Study of KMAG Measurement Data

Hyeonhu Park[1], Ho Jin[1], Wooin Jo[1], Kwan-Hyuk Kim[1], Ian Garrick-Bethell[2], Alex Paul Hoffmann[3]

[1]*School of Space Reseach, Kyung Hee University*
[2]*University of California, Santa Cruz*
[3]*University of Michigan, Ann Arbor*

09:30 [II-2-3]

Contributions of LSMAG Instrument to the Lunar Lander

Juhyeong Kim[1], Ho Jin[1], Seungmin Lee[1], Hyeonhu Park[1], Yunho Jang[1], Hyeonji Kang[1], Junhyun Lee[2], Wooin Jo[1], Hyojeong Lee[3], Seongwhan Lee[3], Young-Jun Choi[4,5], Chae Kyung Sim[4,5], Dukhang Lee[4], Seul-Min Baek[4], Jehyuck Shin[4]

[1]*School of Space Research, Kyung Hee University*

[2]*Department of Astronomy and Space Science, Kyung Hee University*
[3]*NARA Space Technology*
[4]*Korea Astronomy and Space Science Institute*
[5]*Korea National University of Science and Technology*

09:45 [II-2-4]

Initial Estimation of Electrical Conductivity of the Uppermost Layer of the Moon on the Farside with KPLO Magnetometer

Wooin Jo[1], Ian Garrick-Bethell[2], Ho Jin[1], Shahab Fatemi[3], Andrew Poppe[4], Hyeonhu Park[1], Khan-Hyuk Kim[1]

[1]*Kyung Hee University*
[2]*University of California, Santa Cruz, USA*
[3]*Umea University, Sweden*
[4]*University of California, Berkeley, USA*

10:00 [II-2-5]

Spectral Modeling of Apollo Soil 10084 Based on Grain Size

Eunjin Cho[1], Chae Kyung Sim[2,3], Minsup Jeong[2], Young-Jun Choi[2,3], Yu Yi[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

10:15 [II-2-6]

Effectiveness of Lunar Regolith as Shielding Material on the Surface of Moon against GCR and Secondary Radiation

Lasany Arfin Kunja[1], Eojin Kim[1], Jongdae Sohn[2], Yu Yi[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

10:40 [III-2-1]

Global Lunar Exploration Status and Analysis

Yong-Sik Yoon, Jong-Min Im, Hee-Kwang Eun

Korea Aerospace Research Institute

10:55 [III-2-2]

Flagship Program and Roadmap Research for Domestic Space Science, Exploration and Utilization

Gi-Hyuk Choi, Dae-Yeoung Kim, Joo-hee Lee, Yeongyu Kim, Seoyoung Jeong

Korea Aerospace Research Institute

11:10 [III-2-3]

Efficient Preliminary Design of Low-Thrust Interplanetary Trajectories Involving Gravity Assists Using Shape-Based Intercept Arcs

Pureum Kim, Sang-Young Park

Yonsei University

11:25 [III-2-4]

Classification of Subgroups within the SOHO Sungrazing Kreutz Comet Group Using the DBSCAN Clustering Algorithm and Analysis of Asymptotic Incoming Directions

Ulkar Karimova, Yu Yi

Chungnam National University

11:40 [III-2-5]

Verifying Observation Records of Comet C/1652 Y1 from Korean Chronicles

Byeong-Hee Mihn[1,2,3], Ki-Won Lee[4], Uhn Mee Bahk[2], Sang Hyuk Kim[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungbuk National University*
[3]*University of Science and Technology*
[4]*Daegu Catholic University*

11:55 [III-2-6]

Development of Armillary Clocks and Alarm Clocks in Korea: From the Mid-17th Century to the Mid-19th Century

Sang Hyuk Kim[1], Kyoung Uk Nam[2], Byeong-Hee Mihn[1,3,4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Gwacheon National Science Museum*
[3]*Chungbuk National University*
[4]*Korea University of Science and Technology*

13:30 [IV-2-1]

Introduction to the Development Status of Green Propellant-Based Propulsion System for Domestic Orbital Transfer Vehicle Development

Daeban Seo, Hyunjun Kim, Seongmin Joo, Su-Jin Choi, Kuem-Oh Lee, Keejoo Lee,

Jaesung Park

Korea Aerospace Research Institute

13:45 [IV-2-2]

Development of Device Level Space Components for Satellite Application

Young-Jun Cho

Korea Aerospace Research Institute

14:00 [IV-2-3]

Enabling Platform Development for In-Space Pharmaceutical Manufacturing

Hyeonjun Kim[1], Jun-uk Shim[2], Hargsoon Yoon[2], Daeban Seo[1], Sungmin Joo[1], Keejoo Lee[1], Jaesung Park[1]

[1]*Korea Aerospace Research Institute*
[2]*Space Liintech*

14:15 [IV-2-4]

Orbit Determination Accuracy Analysis of GEOKOMPSAT-3 Based on Ground Ranging

Bong-Kyu Park, Jun Hyoung Yoll, Park Keun Joo

Korea Aerospace Research Institute

제3발표장 (Convention C)

09:00 [II-3-1]

Comprehensive Multi-Omics Analysis Approaches Revealed Alteration Mechanisms by Spaceflight

Man S. Kim

Translational-Transdisciplinary Research Center, Clinical Research Institute, Kyung Hee University Hospital at Gangdong, Kyung Hee University College of Medicine

09:30 [II-3-2]

Open New Horizon with L4 Mission: Vision and Planning

K.-S. Cho[1], J. Hwang[1], E.-K. Lim[1], J.-Y. Han[1], S.-H. Choi[1], J. Seough[1], R.-S. Kim[1], S.-H. Park[1], Y.-S. Kim[1], J.-D. Sohn[1], J.-H, Baek[1], J. -Y. Kwak[1], Y.-J. Moon[2], J. Seon[2], K.-S. Ryu[3], C.-H, Lee[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Kyung Hee University*
[3]*Korea Advanced Institute of Science and Technology*
[4]*Korea Areospace Industries*

09:45 [II-3-3]

Preliminary Concept Design Result of Space Probe for L4 Mission

Hwayeong Kim[1], Hyeon-Jeong Park[1], Jaehwee Doh[1], Jong-Jin Jang[1], Chang-Han Lee[1], Hyun-Suk Seo[1], Kyung-Suk Cho[2]

[1]*Korea Aerospace Industries, Ltd.*
[2]*Korea Astronomy and Space Science Institute*

10:00 [II-3-4]

Scientific Suggestions of the Heliophysics L4 Mission by Remote-Sensing Observations

Yong-Jae Moon[1], Kyung-Suk Cho[2], Sung-Hong Park[2], Eun-Kyung Lim[2], Roksoon Kim[2], Donguk Song[2], Jongyeob Park[2], Eunsu Park[2], Harim Lee[1], Hyun-Jin Jeong[1], Jihye Kang[1], Il-Hyun Cho[1], Hyeonock Na[1], Jinhye Park[1], Kangwoo Yi[1]

[1]*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*
[2]*Korea Astronomy and Space Science Institute*

10:15 [II-3-5]

Chromospheric Imaging Spectrograph for L4 Mission: Status and Plans

Eun-Kyung Lim, Donguk Song, Jeong-Yeol Han, Sung-Hong Park, L4 Team

Korea Astronomy and Space Science Institute

10:40 [III-3-1]

L4 Mission: Conceptual Opitcal Design for H-Alpha Imaging Spectrograph

Hyoung-Kwon Lee[1], Jae-Hyun Kyeong[1], Eun-Kyung Lim[2], Jeong-Yeol Han[2,3], Donguk Song[2], Sung-Hong Park[2], Kyung-Suk Cho[2], Seong-Whan Choi[2], Roksoon Kim[2], Jiwoo Lee[2,3]

[1]*LeO SPACE Inc.*
[2]*Korea Astronomy and Space Science Institute (KASI)*
[3]*University of Science and Technology (UST)*

10:55 [III-3-2]

Progress on a Feasibility Study of Deploying a Solar Vector Magnetograph for a Future L4

Mission

Sung-Hong Park, Kyung-Suk Cho,
Eun-Kyung Lim, Donguk Song, Jeong-Yeol Han,
Eunsu Park, Seonghwan Choi, Roksoon Kim,
Jongyeob Park, Ji-Hye Baek

Korea Astronomy and Space Science Institute

11:10 [III-3-3]

Heliospheric Imager for the Lagrange L4 Mission

Roksoon Kim, Kyung-Suk Cho, Jungjoon Seough,
Sung-Hong Park, Eun-Kyung Lim, Junga Hwang,
Donguk Song, Jeong-Yeol Han, Seonghwan Choi

Korea Astronomy and Space Science Institute

11:25 [III-3-4]

Development of EUV Optical Components Machining Technology for L4 Remote Observation

Min-Gab Bog[1], Jin-Seong Jeong[2], Young-Jae Kim[2],
Hong-seop Kim[2]

[1]*Hanbat National University*
[2]*Y&DK Co.*

11:40 [III-3-5]

Ultra-Precision Machining Technology for Fabrication of Reflective Optics Systems

Geon Hee Kim[1,2], Jong Gyun Kang[2], Joong Kyu Ham[2],
Hwan Ho Maeng[2], Seong Hyeon Park[2]

[1]*Department of Defense and Space Engineering, Hanbat University*
[2]*Institute of Space Defense, Hanbat National University*

13:30 [IV-3-1]

Overview of Science Goals and Requirements with *In Situ* Observations at the Sun-Earth Lagrangian Point L4

Dae-Young Lee[1], Rok-Soon Kim[2], Kyung-Eun Choi[3],
Jungjoon Seough[2], Junga Hwang[2], Dooyoung Choi[1],
Ji-Hyeon Yoo[1], Seunguk Lee[1], Sung Jun Noh[4],
Jongho Seon[5], Kyung-Suk Cho[2], Kwangsun Ryu[6],
Khan-Hyuk Kim[5], Jong-Dae Sohn[2],
Jae-Young Kwak[2], Peter H. Yoon[7]

[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Space Sciences Laboratory, UC-Berkeley, USA*
[4]*Los Alamos National Laboratory, USA*
[5]*Kyung-Hee University*
[6]*Satellite Technology Research Center, KAIST*
[7]*University of Maryland, USA*

13:45 [IV-3-2]

Basic Properties of *In Situ* Measurements of Solar Wind Plasma and Outline of Scientific Questions for L4 Mission

Jungjoon Seough[1], Kyung-Suk Cho[1,2], Roksoon Kim[1],
Yukinage Miyashita[1,2], Jong-Dae Sohn[1,2],
Junga Hwang[1,2], Jeong-Yeol Han[1,2], Dae-young Lee[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Chungbuk National University*

14:00 [IV-3-3]

Solar Wind Plasma Analyzer for the Korean L4 Mission: Lessons Learned from the STSAT-1/ESA

Jaeheung Park[1], Jae-Jin Lee[1], Jongdae Sohn[1],
Kyoung Wook Min[2], Jungjoon Seough[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Physics, KAIST*

14:15 [IV-3-4]

Conceptual Study of a High-Energy Particle Detector in the Heliosphere Assuming an L4 Mission

Woo-Hyeong Seol[1], Jongho Seon[1], Khan-Hyuk Kim[1],
Kwangsun Ryu[2], Jungjoon Seough[3], Jongdae Sohn[3],
Junga Hwang[3], Kyung-Suk Cho[3], Dae-young Lee[4]

[1]*School of Space Research, Kyung Hee University*
[2]*Korea Advanced Institute of Science and Technology, Satellite Technology Research Center*
[3]*Korea Astronomy and Space Science Institute*
[4]*Chungbuk National University*

14:30 [IV-3-5]

Conceptual Study of Radiation Monitor for Investigating Space Radiation Environment and Biological Effects at L4 Lagrange Point

Jongdae Sohn[1], Ukwon Nam[1], Jungjoon Seough[1],
Junga Hwang[1], Kyung-Suk Cho[1], Jongho Seon[2],
Kwangsun Ryu[3], Dae-young Lee[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*School of Space Research, Kyung Hee University*
[3]*Satellite Technology Research Center, KAIST*
[4]*Chungbuk National University*

제4발표장 (Vega Hall)

10:40 [III-4-1]

Suggestion of Space Weather Forecasting Criteria for Military Operations

Ho-Sung Choi

Republic of Korea Army (ROKA)

10:55 [III-4-2]

Ionospheric Storm Trend Expected in Solar Cycle 25

Jong-Kyun Chung, Junseok Hong, Byung-Kyu Choi, Dong-Hyo Sohn

Korea Astronomy and Space Science Institute

11:10 [III-4-3]

AstroLibrary: The Engine for Quick and Easy Development of K-STM

Shawn SH Choi[1,2,3], Junny Joo[1], Yusang Lee[1,4], Peter JH Ryu[1,2], Douglas DS Kim[1,2,3]

[1]*SPACEMAP Inc.*
[2]*Voronoi Diagram Research Center, Hanyang University*
[3]*School of Mechanical Engineering, Hanyang University*
[4]*Department of Computer Science, Hanyang University*

11:25 [III-4-4]

K-DRIFT: Off-Axis Freeform Telescope for Optimal Detection of the Low-Surface-Brightness Celestial Objects

Jongwan Ko[1,2,] K-DRIFT Team

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

11:40 [III-4-5]

Orbital Decay of Low Earth Orbit Satellite

Byoung-Sun Lee[1,2], Junho Lee[3], Junmo Kim[4]

[1]*Electronics and Telecommunications Research Institute (ETRI)*
[2]*University of Scienct and Technology (UST)*
[3]*Korea Aerospace Industries (KAI)*
[4]*Soletop*

11:55 [III-4-6]

SNIPE-II Mission

Jaeheung Park[1], Jae-Jin Lee[1], Jongdae Sohn[1], Tae-Yong Yang[1], Hosub Song[1], Young-Joon Jung[1,2], Youngbum Song[1]

[1]*Korea Astronomy and Space Science Institute (KASI)*
[2]*Republic of Korea Army (ROKA)*

13:30 [IV-4-1]

Deep Learning-Based Ground Vehicle Detection Using Satellite SAR Images

Ji-Hoon Park, Ji Hee Yoo, Inho Seo, Kyeung Keun Kim

Agency of Defense Development

13:45 [IV-4-2]

SpaceSCANeR: Development of Surveillance and Reconnaissance Cube Satellites

Tae-Yong Yang[1], Jaejin Lee[1], Daehee Lee[1], Goo-Hwan Shin[2], Soojong Pak[3], Geon Hee Kim[4], SpaceSCANeR Team[5]

[1]*Korea Astronomy and Space Science Institute*
[2]*Satellite Technology Research Center, KAIST*
[3]*Kyung Hee University*
[4]*Department of Defense and Space Engineering, Hanbat University*
[5]*SpaceSCANeR Team*

14:00 [IV-4-3]

Experimental Demonstration of a Newly Designed Optical Communications Terminal (OCT) at a Distance of 20 km

Wonseok Kang[1], Taewoo Kim[1], Sang Hoon Oh[1], Yong-Sun Park[1,2], Jung-Hoon Kim[1,3]

[1]*Spacebeam, Inc.*
[2]*Seoul National University*
[3]*SETsystem, Inc.*

14:15 [IV-4-4]

CubeSat and CubeSat Constellation for Military

Jae-Pil Park, Geuk-Nam Kim, Jinyoung Shin, Seongwhan Lee, Jung-Kyu Lee, Kwangwon Lee

Nara Space Technology

16:20 [정책포럼 II-1]

Policy Suggestions for Establishing the National Space Exploration Roadmap

Hyoung Joon An

Science and Technology Policy Institute

16:20 [정책포럼 II-2]
Strategic Vision for KASA: Setting Scientific Goals and Supporting Concept Studies

Minsun Kim

Korea Astronomy and Space Science Institute

16:20 [정책포럼 II-3]
Recent Activities of ISECG and Its Implication

Dong Young Rew, Soyoung Chung, Yee-Jin Cheon, Ami Yoon

Korea Aerospace Research Institute

16:20 [정책포럼 II-4]
International Legal Review of National Plans for Space Resource Mining and Its Implications for Commercial Space Exploration Strategies

Ryun Young Kwon

Korea Astronomy and Space Science Institute

4월 26일(금)

제1발표장 (Convention A)

10:40 [V-1-1]
Trends and Implications of Space Exploration Missions Using Solar Propulsion

Hyun-Su Lim, Dong-Young Rew, Sang-Seob Park

Korea Aerospace and Research Institute

10:55 [V-1-2]
Transverse Efficiency for Diffractive Solar Sailing, and Comparison with Reflective Sailing

Hyeon-Jin Jeon

Korea Aerospace Research Institute

11:10 [V-1-3]
Consideration of Satellite Electrical System Requirements for Diffractive Solar Sailing

Sangman Moon, Changkyoon Kim, Inkyu Kim,

Korea Aerospace Research Institute

11:25 [V-1-4]
A Survey on the Solar Sail Communication Frequency Spectrum Band

In-Kyu Kim, Sang-Man Moon, Chang-Kyoon Kim, Yee-Jin Cheon

Korea Aerospace Research Institute (KARI)

11:40 [V-1-5]
Mechanical Characteristics of Space Solar Sail Spacecrafts

Min-Ki Kim, Seung-Yong Min, Beom-Suk Kang

Korea Aerospace Research Institute

제2발표장 (Convention B)

10:40 [V-2-1]
Establishment of Requirements and Initial Calculation for ECliPSE's Three Reaction Wheels for Attitude Control

Chae Yoon Kim[1], Heesu Yang[2], Hojin Lee[2], Du Won Ki[1], Jeon Min Hyeok[1], Gybum Kim[1], Ji Eun Choi[3]

[1]*Korea Aerospace University*
[2]*Korea Astronomy and Space Science Institute, UST*
[3]*Chungnam National University*

10:55 [V-2-2]
Analyzing Satellite Aurora Observations for CAS500-3/ROKITS Image Applications

Se Rin Jeon[1], Woo Kyoung Lee[2,3]

[1]*Department of Geological Sciences, Chungnam University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

11:10 [V-2-3]
Near-Infrared Imaging-Spectroscopic Observations of the Moon: Drift Scanning Method Reveals 1μm Absorption Line Features at Reiner Gamma

Minwook Kang[1], Namhun Kim[1], Jayeon Lee[1], Yangha Ju[1], Heesu Yang[2]

[1]*Department of Astronomy & Space science, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

11:25 [V-2-4]

Design of Jupiter's CH^4 Spectroscopic Observation System and Analysis of Its Spectral Data

Seungye Lee[1], Seungmo Hong[1], Heesu Yang[2]

[1]*Department of Astronomy and Space Science, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

11:40 [V-2-5]

Imaging-Spectroscopic Observations of the Sun Using the Drift-Scanning Technique

Jeonghyoen Lee[1], Jiyoon Jeon[1], Uijin Gu[1], Hana Kim[1], Daewon Kim[1], Heesu Yang[2]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute, KASI*

11:55 [V-2-6]

Pre-Processing of the Imaging Spectroscopic Data

Hana Kim[1], Heesu Yang[2], Junghyun Lee[1], Uijin Gu[1], Jiyoon Jeon[1], Daewon Kim[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

제3발표장 (Convention C)

10:40 [V-3-1]

Conceptual Design of a Fluxgate Magnetometer for L-4 Mission

Seunguk Lee[1], Kwangsun Ryu[1], Dooyoung Choi[2], Jimin Hong[1], Su-Hwan Park[1], Enno B. Starossek[3], Jae-Young Kwak[4,5], Yukinaga Miyashita[4,5], Jungjoon Seough[4], Jaeheung Park[4,5], Junga Hwang[4,5], Jong-Dae Sohn[4], Kyung-Suk Cho[4,5], Dae-Young Lee[2]

[1]*Satellite Technology Research Center, KAIST*
[2]*Chungbuk National University*
[3]*Department of Aerospace Engineering, KAIST*
[4]*Korea Astronomy and Space Science Institute*
[5]*University of Science and Technology*

10:55 [V-3-2]

The Primarily Study of Search Coil Magnetometer for Space Research

Ho Jin, Kwan-Hyuk Kim

School of Space Reseach, Kyung Hee University

11:10 [V-3-3]

Conceptual Design of Electric Field and Radio/Wave Detector for L-4 Mission

Kwangsun Ryu[1], Seungwook Lee[1], Jimin Hong[1], Su-Hwan Park[1], Enno B. Starossek[2], Jaeyoung Kwak[3,4], Yukinaga Miyashita[3,4], Jungjun Seough[3], Jongdae Sohn[3], Junga Hwang[3,4], Jaeheung Park[3,4], Kyungsuk Cho[3,4], Jongho Seon[5], Khan-Hyuk Kim[5], Kyung Chan Kim[6], Dae-Young Lee[6]

[1]*Satellite Technology Research Center, KAIST*
[2]*Department of Aerospace Engineering, KAIST*
[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*
[5]*School of Space Research, Kyung Hee University*
[6]*Chungbuk National University*

11:25 [V-3-4]

Preliminary Study of Deployable Boom Structures for an L-4 Mission

Enno B. Starossek[1], Jae-Hung Han[1,2], Kwangsun Ryu[2], Seunguk Lee[2], Kyung-Suk Cho[3,4], Yukinaga Miyashita[3,4]

[1]*Department of Aerospace Engineering, KAIST*
[2]*Satellite Technology Research Center, KAIST*
[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*

11:40 [V-3-5]

Dust Detector and Science

Thiem Hoang[1,2], Kyungsuk Cho[1], L4 team

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea University of Science and Technology*

제4발표장 (Vega Hall)

10:40 [V-4-1]

Analysis of the Orbit Maneuvers of North Korea's MALLIGYONG-1 Satellite Using Space Surveillance Radar Tracking

Eun-Jung Choi

Korea Astronomy and Space Science Institute

10:55 [V-4-2]

Observational Strategies for Optimal Operation of NSOS-α

Hee-Jae Lee, Myung-Jin Kim, Youngmin JeongAhn, Hong-Kyu Moon, Dong-Goo Roh, Hong-Suh Yim, Jaemann Kyeong, Jung Hyun Jo, Jang-Hyun Park, Sungki Cho

Korea Astronomy and Space Science Institute

11:10 [V-4-3]

NSOS-Beta (Near Space Optical Survey-Beta): Objectives and Operation

Jin Choi, Jung Hyun Jo, Hong-Suh Yim, Dong-Goo Roh, Myung-Jin Kim, Jang-Hyun Park, Jaemann Kyeong, Sungki Cho, Eun-Jung Choi, Jiwoong Yu, Seong-Yeol Yu, YeonGil Jung, Wookyung Lee, Hong-Kyu Moon

Korea Astronomy and Space Science Institute

11:25 [V-4-4]

The Construction of ADS-B Receiving System for Aircraft Surveillance Detection in Sejong SLR System

Ki-Pyoung Sung, Man-Soo Choi

Korea Astronomy and Space Science Institute

포스터발표 논문 제목

4월 25일(목) 14:50~16:20

▶ 우주 인프라

[P-1] A Flexible 1553B Interface Design for Sharing the BUS of Multiple External Unit

Seung-Eun Yang

Korea Aerospace Research Institute

[P-2] Comparison and Evaluation of Air-Cooled Dry Pump Performance for Thermal Vacuum Chambers

Sung-Wook Park[1], Sun-ki Baek[2], Keun-sik Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*Hanyang ENG*

[P-3] VxWorks Downloadable Application Build for Flight Software Development

Su-Hyun Park

Korea Aerospace Research Institute

[P-4] Measuring Astronomical Seeing at Jang Bogo Station

Chung-Uk Lee[1], Hyuck-Jin Kwon[2], Dong-Joo Lee[1], Jong-Kyun Chung[1], Changsup Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Polar Research Institute*

[P-5] A Study on Ways to Improve the Technical Document Registration Process for Configuration Management Baseline Management

Chul Kang

Korea Aerospace Research Institute+

[P-6] A Study on the Utilization of GLORIAD Network for Advanced Multi-Satellite Operation

Hyun-Chul Baek, Tae-Gun Son, Jae-Hyoung Park

Korea Aerospace Research Institute

[P-7] Ground Communication Loss Check

Dong-Seok Chae

Korea Aerospace Research Institute

[P-8] The Launch Vehicle Mechanical Interface Check and Separation Shock Test of Large Optical Satellite Flight Model

Kilyong Hwang[1], Chihyun Cho[2], Kyungwon Kim[1], Heekwang Eun[1], Gyusun Kim[1]

[1]*Korea Aerospace Research Institute*
[2]*Korea Aerospace Industries*

[P-9] Study of the Dedicated Test Equipment for In-Plane Shock Excitation

Jong-Hyub Jun, Hee-Kwang Eun, Nam-Jin Moon, Jin Park, Chang-Rae Cho, Tae Seok Oh

Korea Aerospace Research Institute

[P-10] Analysis of Star Imaging Window for the Image Calibration of Optical Earth Observation Satellite in Low Earth Orbit

Jeong Hoon Hyun

Korea Aerospace Research Institute

[P-11] Early Operation Scenario Analysis for Initial Signal Acquisition and Communication of Low Earth Orbit Satellite

Kyunsang Park

Korea Aerospace Research Institute

[P-12] Statistical Analysis of Mission Planning for Geostationary Satellites

Hye-Won Kim, Sang Cherl Lee

Korea Aerospace Research Institute

▶ 우주 산업

[P-13] Development of Space-Class Custom Magnetic

Wooje Han[1], Kyunghee Kim[1], Juhong Oh[1], Derac Son[2], Dongsu Son[2], Seongkeun Jeong[3]

[1]*Korea Testing Laboratory*
[2]*Sensorpia Inc.*
[3]*MID Inc.*

[P-14] Considerations for the Design of Power supply for the Signal Processor of Focal Point Unit of Low Earth Orbit Satellite

Young-Yun Kim, Young-Sun Kim, Jong-Pil Gong,

Haeng-Pal Heo
Korea Aerospace Research Institute

[P-15] Analysis of TDI MTF Degradation due to the Optical Distortion of Electro-Optical Camera

Jeoung-Heum Yeon, Eung-Shik Lee
Korea Aerospace Research Institute

[P-16] Study for Improving Transients and Surges due to Initial Power Supply to Satellites

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[1]*Korea Aerospace Research Institute*
[2]*HANCOM in SPACE*

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[1]*Korea Aerospace Research Institute*
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[1]*Korea Aerospace Research Institute*
[2]*I-OPS*

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Korea Aerospace Research Institute

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[2]*Department of Electronic Engineering, Kyung Hee University*
[3]*Department of Electronic Engineering, Hanyang University*
[4]*Department of Astronomy and Space Science, Kyung Hee University*

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[1]*School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

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Kilho Baek[1], Sungsoo S. Kim[1], Chae Kyung Sim[2,3]

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[2]*Korea Astronomy and Space Science Institute (KASI)*
[3]*Korea National University of Science and Technology (UST)*

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Jun-Hyeon Kim, Seung-Jun Oh, Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

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Chae-Ryeong Kim, Yang-Ha Ju, Seok-Min Song, Yu Yi

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[1]*SELab. Inc,.*
[2]*ChungNam University*
[3]*Korea Space Weather Center, RRA*

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Suyeon Oh[1], Myunghwan Kim[1,2], Jongil Jung[3], David Selvaraj[1]

[1]*Chonnam National University*
[2]*Gwangju Science Academy for the Gifted*
[3]*Korea Astronomy and Space Science Institute*

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Jieun Choi[1], Jaeyoung Kwak[2,3], Eunsu Park[2]

[1]*Department of Astronomy and Space Science, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

[P-66] Classification of Ionograms in the Polar Region by the Vertical Incidence Pulsed Ionospheric Radar at Jang Bogo Station, Antarctica

Junho Back[1,2], Geonhwa Jee[2,3], Hyuck-Jin Kwon[2], Khan-Hyuk Kim[1], Changsup Lee[2,3], Young-Bae Ham[2,3]

[1]*School of Space Research, Kyung Hee University*
[2]*Division of Atmospheric Sciences, Korea Polar Resarch Institue*
[3]*Department of Polar Scienc, Korea University of Science and Technology*

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Seohee Jang[1], Sung-Hong Park[2]

[1]*Chungbuk National University*
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[3]*Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan*

[4]*Kyoto University*
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Sung-Hong Park[1], Seonghwan Choi[1], Jihye Baek[1], Eunsu Park[1], Jeong-Heon Kim[1], Hwanhee Lee[1], Roksoon Kim[1], Jongyeob Park[1], Yong-Jae Moon[2], Harim Lim[2], Chanwoo Kim[3], Taeyoung Kim[4]

[1]*Korea Astronomy and Space Science Institute*
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[4]*AIFactory*

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Jong-Woo Kwon[1], Hyuck-Jin Kwon[1], Geonhwa Jee[1], Khan-Hyuck Kim[2]

[1]*Korea Polar Research Institute*
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Yujin Cho[1,2], Geonhwa Jee[1,2], Young-Bae Ham[1,2], Hyuck-Jin Kwon[1], Ji Eun Kim[1]

[1]*Korea Polar Research Institute*
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Hojin Lee[1,2], Ji Eun Choi[3], Gybum Kim[4], Chae Yoon Kim[4], Won Ki Du[4], Min Hyeok Jeong[4], Heesu Yang[1], Jaeheung Park[1,2]

[1]*Korea Astronomy and Space Science Institute*
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Donguk Song[1,2], Eun-Kyung Lim[1], Jongchul Chae[3], Yeon-Han Kim[1], Yukio Katsukawa[2], Vasyl Yurchyshyn[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*National Astronomical Observatory of Japan*
[3]*Seoul National University*
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Jinhye Park[1], Hyeon-Ok Na[1], Yong-Jae Moon[1,2]

[1]*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*

[P-76] Comparison of Solar Flare Detection Results between Deep Learning-Based Object Detection Models: SSD and Faster R-CNN

Seung-Ye Lee[1], Ji-Hye Baek[2], Eunsu Park[2], Seonghwan Choi[2]

[1]*Department of Astronomy and Space Science, Chungnam National University,*
[2]*Korea Astronomy and Space Science Institute*

[P-77] Retrieval of the Characteristics of Local Thermospheric Winds over the Korean Peninsula

Jaewook Lee[1,2], Young-Sil Kwak[1,2], Hosik Kam[2], Jeong-Heon Kim[2], Tae-Yong Yang[2]

[1]*University of Science and Technology*
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[P-78] How Much Can We Remove the Ambiguity of 3D CME Geometry Determination by Multi-View Observations

Hyeonock Na[1,] Yong-Jae Moon[1,2]

[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*

[P-79] Strong Solar Radio Burst Observed by eCALLISTO in KASI

Sujin Kim[1], Hongdal Jun[1,2], Su-Chan Bong[1]

[1]*Korea Astronomy and Space Science Institute*
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[P-80] Establishment of Requirements and Initial Design for ECliPSE (Experiment Corona Using baLloon Radiosonde Pointing Sun Essential) Thermal Control

Gybum Kim[1], Hojin Lee[2,3], Ji Eun Choi[2], Chae Yoon Kim[1], Min Hyeok Jeong[1], Won Ki Du[1], Heesu Yang[2]

[1]*Korea Aerospace University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

[P-81] Study of the Geomagnetic Disturbance during the Solar Minimum Period

Jun Wook Park, Kyung Sun Park

Department of Astronomy and Space Science, Chungbuk National University

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[P-82] Frequency Coordination Activities for Earth Stations in Geostationary Satellite Programs

Seorim Lee

Korea Aerospace Research Institute

[P-83] Standard Procedure for Selecting a Satellite Launch Vehicle Considering Various Situations

Eungsik Park, Wonsuk Lee, Jonghwi Choi

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[P-84] Management Strategies for Multi-Agency R&D Projects

Ji-Mo Yang, Keun-Woong Shin, Eung-Sik Park

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[P-85] Launch Status of CAS500 Satellite Series

Keun-Woong Shin, Ji-Mo Yang, Jong-Hwi Choi, Dong-In Han, Eung-Sik Park

Korea Aerospace Reasearch Institute

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[P-86] Observational Tools with Nam Byeong-Cheol's Armillary Sphere

Hong Soon-Choi[1,2], Sang Hyuk Kim[1], Byeong-Hee Mihn[1,2,3], Kyoung-uk Nam[4], Kyeong-han Yoo[2], Yong-gi Kim[2,5]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungbuk National University*
[3]*Korea University of Science and Technology*
[4]*Gwacheon National Science Museum*
[5]*Chungbuk Pro Maker Center*

[P-87] Estimation of Zernike Coefficients in Polygonal Optical Mirror Using Machine Learning

Shinwook Kim, Youngchun Youk, Haengpal Heo

Korea Aerospace Research Institute (KARI) Satellite Payload R&D Division

▶ 학부생 세션

[P-88] Development of a Small Slit Spectroscope for Observing Jupiter Using a 3D Printer

Seungye Lee[1], Seungmo Hong[1], Heesu Yang[2]

[1]*Department of Astronomy and Space Science, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

▶ 마이크로 중력 환경 활용

[P-89] Analysis of Various Conditions for Undersea Platform Utilization of Space Life Support System

Joohee Lee, Younkyu Kim, Jongwon Lee, Ikhyun Choi, Gihyuk Choi

Korea Aerospace Research Institute

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[P-90] Overview of Cold-Gas Propulsion Subsystem for SpaceSCANer Mission

Hosub Song[1], Dae-Hee Lee[1,2], Jaejin Lee[1]

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구두발표 논문 초록

4월 24일(수) 제1발표장 Convention A

Invited Talk

Chair: 조경석(천문연)

13:50 [IS]

NASA Organization and the Roles of Program Scientists and Program Executives

John Lee

Retired NASA Senior Executive

This presentation will provide an overview of NASA structure by examining various offices at Headquarters and Field Centers. This presentation will focus on the structure of the Science Mission Directorate and the Heliophysics Division, and the roles of Program Scientists and Program Executives.

제1발표장 Convention A

I-1 태양 및 우주환경 I

Chair: 박성홍(천문연)

16:20 [I-1-1]

Development of a Diagnostic Coronagraph on the ISS: CODEX Progress Report

Yeon-Han Kim[1], Su-Chan Bong[1], Seonghwan Choi[1], Kyungsuk Cho[1,2], Jeffrey Newmark[3], Nat. Gopalswamy[3], KASI-NASA Coronagraph Team

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[3]*NASA Goddard Space Flight Center, USA*

The Coronal Diagnostic Experiment (CODEX) is a KASI-NASA joint project to develop a diagnostic coronagraph on the International Space Station, which is designed to obtain simultaneous measurements of the electron density, temperature, and velocity using multiple filters in the 2.75-10 Rs range. After completing the CODEX coronagraph integration in April 2023, its optical performance test was performed at the INAF (National Institute for Astrophysics) facility in Italy. The system-level integration of the CODEX, the integration of the coronagraph and the pointing system, was started from June 2023 and completed in November 2023. The system-level environment tests were performed until February 2024 and the final software update has been in progress. Recently, the CODEX launch was set in September 2024. In this presentation, we will introduce recent progress and future plan.

16:35 [I-1-2]

Observation of Low-Earth Orbit Space Radiation Environment in by LEO-DOS on Board NEXTSat-2

Uk-won Nam[1], Won-Kee Park[1], Jaeyoung Kwak[1,2], Jongdae Sohn[1], Bongkon Moon[1], Jaejin Lee[1], Young-Jun Choi[1], Sunghwan Kim[3], Hongjoo Kim[4], Sung-Joon Ye[2], Hongyoung Park[5], Taeseong Jang[5], Sukwon Youn[6]

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[2]*University of Science and Technology*
[3]*Department of Radiology, Cheongju University*
[4]*Department of Physics, Kyungpook National University*
[5]*Satellite Technology Research Center, KAIST*
[6]*Radiological Physics Laboratory, Seoul National University*

The LEO-DOS (Low-Earth Orbit Space Radiation Dosimeter) has been successfully measuring the local space radiation environment as a science payload of the Korea Next Generation Small Satellite 2 (NEXTSat-2) since its successful launch on May 25, 2023. The NEXTSat-2 orbits at an average altitude of about 545 km with a 98.7 degree inclination. We provide radiation dose estimates for charged particles and neutrons from four source categories: (i) galactic cosmic ray particles; (ii) the South Atlantic Anomaly region of the inner radiation belt (IRB); (iii) relativistic electrons and/or bremsstrahlung in the outer radiation belt (ORB); and (iv) solar energetic particle (SEP) events. This paper presents the LEO-DOS dose rates measured from June 2023 to March 2024. Neutron dose rates in LEO are novel in these measurements.

This work was supported by the National Research Foundation of Korea (NRF) Grant funded by the Korea government (MSIP) (NRF-2017M1A3A4A01077173) and (NRF-2020M1A3B7108845).

16:50 [I-1-3]

KASI NRT Ionospheric Monitoring System Using GNSS network

Woo Kyoung Lee[1,2], Byung-Kyu Choi[1], Dong-Hyo Sohn[1], Sung-Moon Yoo[1], Kyoung-Min Roh[1], Juneseok Hong[1], Se Heon Jeong[1], Tae-Young Yang[1], Jaeheung Park[1,2], Jong-Kyun Chung[1], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

In this presentation, we present the KASI near-real-time (NRT) ionospheric monitoring system over Korea using GNSS data. Monitoring the ionosphere plays a crucial role in radio

communications and navigation purposes. Global Navigation Satellite Systems (GNSS) offer a valuable tool for continuous ionospheric observation due to their 24/7 availability. Our system generates maps of Total Electron Content (TEC) and Rate of TEC (ROTI) every 15 minutes with GPS data from 40 stations. Starting in 2024, the NRT monitoring system will deploy TEC/ROTI data derived from the Japanese Quasi-Zenith Satellite System (QZSS), which includes one geostationary satellite and three geosynchronous orbit satellites with inclinations. This enhancement facilitates continuous ionospheric monitoring at the same location, enabling the retrieval of velocity and directional information about ionospheric perturbations. Additionally, KASI is in the process of establishing a GNSS scintillation observation network along a meridional chain. This network encompasses two stations in Korea, one in Micronesia, and another in Antarctica. KASI has also developed a regional TEC prediction model employing a deep learning approach. By utilizing a 20-year TEC dataset, this prediction model adeptly forecasts TEC values 24 hours in advance. In addition to terrestrial GNSS data, KASI has initiated an ionospheric monitoring experiment using ship-borne GNSS data. By equipping research vessels such as ISABU and the ARAON icebreaker with GNSS scintillation receivers, we collect data from maritime regions, enhancing the potential of ionospheric monitoring with ship-borne GNSS data.

17:05 [I-1-4]

Flight Model Readiness of the Langmuir Probe of IAMMAP for CAS500-3 Satellite

Su-Hwan Park, Kwangsun Ryu, Seunguk Lee, Jimin Hong, Seong-og Park, Jinkyu Kim, Bonju Gu, Wonho Cha

Satellite Technology Research Center, KAIST

The Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe (IAMMAP) is one of the scientific payloads for the Compact Advanced Satellite 500-3 (CAS500-3). The Langmuir probe (LP) of IAMMAP is a disk-type probe that measures the plasma current in order to determine the electron density and temperature for monitoring the Equatorial Ionization Anomaly (EIA). In this presentation, we demonstrate the development status of the LP. To meet the requirements of measurement, it is necessary to ensure that the plasma current is correctly detected by the LP analog circuit. Also, we confirm the environmental test of IAMMAP and all requirements are satisfied by the test results. We have developed the Engineering Qualification Model (EQM) and are now developing the Flight Model (FM) reflecting modifications found in the EQM development. In addition to the hardware development, the software to optimize the data analysis with a limited data transfer capacity.

제2발표장 Convention B

I-2 우주인프라

Chair: 서행자(항우연)

16:20 [I-2-1]

Research on Remodeling of Old Telescopes with Unknown Optical Data

Young Jun Park[1,2], Elijah J. H. Kim[1,2], Yun-Young Choi[2,3], Soojong Pak[1,2], Ilhoon Kim[1]

[1]*SLLAB, INC.*
[2]*School of Space Research, Kyung Hee University*
[3]*Department of Astronomy and Space Science, Khung Hee University*

Among the many reflecting telescopes that exist in Korea, some have the problem of not being able to achieve accurate imaging because the original optical design data has disappeared. Research was conducted with the goal of efficiently recycling the optical systems of these telescopes. In this study, the focal length and aperture ratio of the optical system were calculated using the angle of view of the image taken at the beginning of the installation of the 600 mm telescope at the Seosan Ryubangtack Science Museum. Then, the curvature of each point of the primary and secondary mirrors was measured using a spherometer, and based on this, the mirror curve equations of the primary and secondary mirrors were estimated. The estimated mirror surface curves of the primary and secondary mirrors, the position of the existing secondary mirror, and the position of the focal plane were input into the optical design software to derive the optimal primary and secondary mirror positions and focal plane. Finally, this value was compared with the positions of the primary and secondary mirrors and the focal position installed in the previous telescope to finalize the telescope design, and a new optical tube was manufactured based on this design. Through this study, we presented a method to effectively recycle the optical system of a telescope whose optical design data is unknown without the need for optical measurement equipment such as an interferometer.

16:35 [I-2-2]

A Study on the Utilization of KREONET for Advanced Multi-Satellite Operation

Hyun-Chul Baek, Tae-Gun Son, Jae-Hyoung Park

Korea Aerospace Research Institute

To operate satellites developed based on the related national scheme, multiple dedicated networks are required for satellite control and satellite data transmission. However, configuring a

nationwide network is a significant challenge regarding expenses. To address this challenge, it is recommended that a dedicated network be formed and multiple overlay networks be configured on top of it. In this regard, it is most efficient to establish one “KARI Satellite Network (KARISNET)” that can operate multiple satellites and then interlink networks with internal and external institutions in collaboration with KREONET. Since KREONET operates 18 regional networks nationwide, end-sites to be interlinked with KARISNET, such as the National Satellite Center and satellite ground station, can be connected to the nearest regional network center of KREONET via the dedicated circuit of the ISP. With this configuration mechanism, the end-site is the best way in terms of security and performance since it is possible to form a dedicated circuit regardless of the distance from KARISNET. However, this configuration requires the expansion of the KREONET optical backbone at the National Satellite Operation and Application Center, which involves difficulties in optical equipment configuration and management. To address this problem, KREONET has independently established the optical cable facility called SuperSiRen between the KARI and the KISTI. Utilizing this facility makes it possible to connect different network instruments directly. Based on this configuration, dedicated circuits of multiple end-sites can be connected to KARISNET by connecting the router of KARI and that of KARISNET through TRUNK and then allotting the VLAN to each end-site just like a dedicated circuit. Another way is to create an MPLS L2VPN tunnel between the Korea Aerospace Research Institute router and that of KARISNET so that it is connected to each dedicated circuit. Once a dedicated circuit is configured, as stated above, it is possible to establish the L1 circuit securely. However, each layer needs to be considered in protecting L2, L3, and L7 networks at the top level. If a high-security level is required, the NAC needs to be operated to manage the ACL and prevent other terminals from accessing this dedicated network so that the VPN is utilized for such dedicated circuits and a separate IP system solely for VPN tunneling can be used.
This study suggests methods to configure KARISNET for multi-satellite operation and to interlink with end-sites based on KREONET for efficient networking and security enhancement.

16:50 [I-2-3]

Creative Astronomical Instrument Design and Observation: Development of a Small Spectrograph and Observation Using Drift Scanning Method

Heesu Yang, Jong-Kyun Chung

Korea Astronomy and Space Science Institute

The abilities of system engineering and project management are essential in the development of large instrumentations in modern astronomy. We propose a novel undergraduate educational program that allows students to gain experience in system engineering and project management by making and observing simple spectrographs. A pilot program titled “Creative Astronomical Instrument Development and Observation” was conducted at Chungnam National University, as part of the Space Expert Training Program of Ministry of Science and ICT during the Fall semester of 2023. After organizing five teams, each team manufactured the spectrograph and observed a spectrograph to measure line spectra of the Sun, Moon, or planets. Students prepared the system reviews and documents. Through this opportunity, students could learn basic principles of systems engineering and project management, as well as optical and mechanical engineering skills.

17:05 [I-2-4]

Separation Test of a Low Earth Orbit Satellite

Tae Seok Oh, Hee-Kwang Eun, Jong-Hyub Jun, Chang-Rae Cho, Jin Park, Kyung-Won Kim

[1]*Korea Aerospace Research Institute*

A separation test is necessary to verify the structural/functional performance of satellite systems and components against strong impact loads during the separation from the launch vehicle. In this paper, the shock response function (SRS) is measured in the separation test and compared with an environment specification to review the structural safety of a low earth orbit satellite and its components.

제3발표장 Convention C

I-3 초소형위성

Chair: 송영주(항우연)

16:20 [I-3-1]

Development of Simulator for Energy Balance Analysis of Nano-Satellite

Myung-Kyu Lee[1], Seul-Hyun Park[2]

[1]*Graduate School of Chosun University*
[2]*Department of Mechanical Engineering, Chosun University*

Nano-satellite offer faster development times and lower costs compared to traditional satellites, making them adaptable for experimenting with new technologies. They are used for space technology validation, research missions, and commercial models. However, due to their small size and weight, nano-satellite cannot maintain a continuous power supply. This study aims to develop a simulator to analyze and improve the energy balance of a 3U nano-satellite, presenting a system design that

effectively models and simulates energy balance for optimal architecture. The simulator's energy balance process was modeled and simulated under various operational conditions and mission scenarios, and the results were compared to actual satellite orbit data. The proposed simulator's analysis results were highly comparable to the satellite's orbit data.

16:35 [I-3-2]

The Current Status and Re-Launch Readiness after Non-Deployment of JINJUSat-1

Mintae Lee[1,2], Hana Jung[1], Hongju So[1], Kyunghee Kim[1]

[1]*Space Testing Center, Korea Testing Laboratory*
[2]*Department of Aerospace Engineering, Gyeongsang National University*

The 2U-sized Nano-satellite JINJUSat-1 was developed with the support of the local government with the primary purpose of training specialized personnel for the regional space industry. JINJUSat-1 was launched abroad Space X's Falcon 9 from Vandenberg Air Force Base, California, USA, on November 11, 2023, according to Pacific Standard Time. However, JINJUSat-1 did not deploy from the deployer mounted on Falcon 9 by unidentified reasons. This paper aims to present the developments identified since the non-deployment incident and introduce alterations and progress made in the preparation process for JINJUSat-1's re-launch decision.

16:50 [I-3-3]

Design and ETB Test Results of Attitude Maneuvering Profile Software (AMPS) for LEO Satellites

Shinhye Moon, Taeseog Kim, Jongjin Jang

Korea Aerospace Industries , Ltd.

To achieve high-resolution imaging of regions of interest, precise attitude control command is essential for satellite operations. This paper introduces Attitude Maneuvering Profile Software (AMPS), a tool specifically designed for generating accurate attitude guidance parameters for Low Earth Orbit (LEO) satellites. AMPS consists of two phases: Imaging and Maneuver. The Imaging phase calculates the attitude profile based on mission planning input values, while the Maneuver phase dynamically adjusts the satellite's attitude to point towards the next target on the ground using Single-Phase, Small-Angle Solution. To optimize data size, AMPS utilizes a reconstruction technique, converting the profile into N-th polynomial parameters. The applicability of AMPS is verified through simulation results obtained from Electrical Test Bed (ETB) tests with the Satellite Dynamics Simulator (SDS). These tests demonstrate that AMPS successfully controls satellite attitude to accurately point towards desired targets. In summary, AMPS serves as a verified software tool for generating precise attitude guidance parameters for LEO satellite imaging applications.

17:05 [I-3-4]

Very High-Resolution Earth Observation in the New Space Era: Achieving 0.3-m GSD Images via Very Low Earth Orbit and Heterogeneous Constellations for Rapid Revisits

Youngwan Choi, Euichan Yoo, Hyoungseok Han, Bokyoung Kwon

CONTEC Space Optics (CSO)

In the dynamic landscape of Earth observation, the demand for high-resolution satellite imagery is escalating across various sectors, encompassing applications ranging from agriculture to urban planning. The image data market is projected to triple by 2028, underscoring the urgency to overcome the limitations in the supply of very-high resolution imagery (<0.5 meters resolution). This paper presents a pioneering approach to address this demand-supply gap by harnessing the capabilities of Very Low Earth Orbit (VLEO) satellites and heterogeneous constellations to acquire 0.3-m Ground Sample Distance (GSD) images with unprecedented temporal resolution.

The title "Very High-Resolution Earth Observation in the New Space Era: Achieving 0.3-m GSD Images via Very Low Earth Orbit and Heterogeneous Constellations for Rapid Revisits" aptly captures the essence of our endeavor. Beyond the applications in agriculture, urban planning, disaster management, and environmental monitoring, our approach holds particular significance in the domains of intelligence, reconnaissance, and surveillance (ISR).

In these critical domains, timely access to high-resolution imagery is paramount for decision-making and situational awareness. By leveraging VLEO satellites and heterogeneous constellations, our methodology empowers intelligence agencies, military forces, and security organizations with the ability to rapidly acquire and analyze 0.3-m GSD imagery, enhancing their capabilities for threat detection, target identification, and mission planning.

Through comprehensive case studies, designs, analyses, we demonstrate the feasibility and effectiveness of our approach in achieving rapid revisit times and global coverage while maintaining exceptional image quality. Furthermore, we explore the transformative potential of 0.3-m GSD imagery in ISR operations, highlighting its ability to provide actionable intelligence, facilitate reconnaissance missions, and support surveillance efforts across diverse operational theaters.

In conclusion, our research underscores the pivotal role of

VLEO satellites and heterogeneous constellations in ushering in a new era of Earth observation, marked by unparalleled spatial and temporal resolution. As the demand for high-resolution imagery continues to surge, innovative solutions like ours promise to revolutionize not only civilian applications but also critical domains such as intelligence, reconnaissance, and surveillance, ensuring heightened security and strategic advantage in an increasingly complex global landscape.

제4발표장 Vega Hall

I-4 안보우주 I

Chair: 최호성(육군)

16:20 [I-4-1]

A Study on the Development of Low-Earth Satellite Cyber Security Policy in the Republic of Korea Army

Hanseok Kim, Byungjoon Jung

Republic of Korea Army

As can be seen in the recent Starlink case, the use of low-orbit satellites is increasing worldwide. However, studies on cybersecurity vulnerabilities of satellites have been steadily presented in countries around the world. Although the Army is also promoting the use of low-orbit satellites in accordance with the 'Basic Plan for the Development of Army Space Force', it has not established a security policy that considers the cybersecurity vulnerabilities of satellites, only considering the concerns about securing and utilizing. In this study, we investigated the cybersecurity vulnerabilities of satellites that have recently emerged and suggest low-orbit satellite security policies that the Army must consider accordingly.

16:35 [I-4-2]

Orbit Design of Lunar Navigation Satellite System for Exploration of Lunar South Pole

JunWon Song[1], Hojoon Jeong[2], Minjae Kang[2,3], Jaeuk Park[2], JoonWang Lee[1], Changdon Kee[2]

[1]*Space/Science & Technology Division, Policy Office, ROKA HQ*

[2]*Department of Aerospace Engineering and the Institute of Advanced Machines and Design, Seoul National University*

[3]*Interdisciplinary Program in Space Systems, Seoul National University*

Countries around the world are planning to build bases at the South pole of the Moon. The moon is an extremely important region both strategically in terms of designated geographical value due to its rarity as a natural resource and as precursor base for deep space exploration. Therefore, a navigation system with high accuracy positioning is necessary to protect national interests arising from lunar exploration. To achieve this, A study conducted research on orbit design for a lunar satellite navigation system aimed at exploring the lunar south pole. The orbit for lunar navigation on the moon is a stable orbit condition considering the special environment of the moon and an orbit with good navigation performance at the south pole. The condition for good navigation performance at the lunar south pole should consider the satellite's geometrical placement, Position Dilution Of Precision (PDOP). In this paper, considering the lunar environment, we analyzed the PDOP as an indicator of navigation performance under stable and various conditions. We proposed a method to utilize this in the orbit design of LNSS as an approach.

16:50 [I-4-3]

A Comparative Study on Space Launch Vehicle Authorization System for Security and Defense Purposes in Major Spacefaring Nations: Focusing on the United States, France and Japan

Woo-seok Lee

Korea National Defense University

The Space Development Promotion Act, which serves as the basic law on national space activities, has become the subject of legal issues despite the trend of military use in Korea today. In order to meet the growing demand for military space assets and to timely inject and operate space assets for security and defense purposes, Korea also needs a legal review of the launch authorization system for space launch vehicles.

First of all, the meaning of the launch authorization system and the background of its enactment were reviewed from the perspective of international law. Under international law, state responsibility for space activities is established through state authorization and supervision. It is common for such authorization and supervision to be interpreted by paying attention to the actions of individuals consisting of non-governmental entities, including private companies, but the deployment of space assets for security and defense purposes also requires authorization from "competent national authorities," just like private space activities.

The domestic legislative system for these space activities and the composition of competent national authorities vary from country to country. However, the United States, France, and Japan's space launch authorization systems for security and defense purposes have significant implications for Korea considering the political and economic similarities. Therefore, among the 12 countries capable of self-launching space objects, the above 3 countries' systems were analyzed focusing on

legislation and national space governance.

17:05 [I-4-4]

Military Application Plan of A CubeSat Satellite for Republic of Korea Army

Young-Joon Jung, Ho-Sung Choi, Joon Wang Lee
Republic of Korea Army (ROKA)

A CubeSat is a subset of a small satellite system known as nano satellites. It has a low per-unit cost; enables low-cost satellite constellations to be structured with minimal manpower and logistic costs. At the same time provides frequent technology renewal opportunities. As a result, recently the number of these CubeSats getting applied for military and defense use are increasing in foreign countries. Military satellites are used not only for reconnaissance, surveillance and communication purposes, but also being developed and utilized for various purposes such as Formation Flight and removal of space debris. In this presentation, we suggest a application plan of A CubeSat for Republic of Korea Army (ROKA), through case studies of CubeSat operations in foreign military.

4월 25일(목) 제1발표장 Convention A

II-1 태양 및 우주환경 II

Chair: 권혁진(극지연)

09:00 [II-1-1]

Observation and Numerical Simulation of Cold Ions Energized by EMIC Waves

K.-K. Kim[1], C.-W. Jun[2], J.-W. Kwon[3], J. Lee[1], K. Shiokawa[2], Y. Miyoshi[2], E.-H, Kim[4], K. Min[5], J. Seough[6]

[1]*School of Space Research, Kyung Hee University*
[2]*Institute for Space-Earth Environmental Research, Nagoya University, Japan*
[3]*Korea Polar Research Institute*
[4]*Princeton Plasma Physics Laboratory, Princeton University, USA*
[5]*Department of Astronomy and Space Science, Chungnam National University*
[6]*Korea Astronomy and Space Science Institute*

This is the first report of significant energization (up to 7,000 eV) of low-energy He^+ ions, which occurred simultaneously with H-band electromagnetic ion cyclotron (EMIC) wave activity, in a direction mostly perpendicular to the ambient magnetic field. The event was detected by the Arase satellite in the dayside plasmatrough region off the magnetic equator on 15 May 2019. The peak energy of the He^+ flux enhancements is mostly above 1,000 eV. At some interval, the He^+ ions are energized up to ~7,000 eV. The H-band waves are excited in a frequency band between the local crossover and helium gyrofrequencies and are close to a linear polarization state with weakly left-handed or right-handed polarization. The normal angle of the waves exhibits significant variation between 0° and 80°, indicating a non-parallel propagation. We run a hybrid code with parameters estimated from the Arase observations to examine the He^+ energization. The simulations show that cold He^+ ions are energized up to more than 1,000 eV, similar to the spacecraft observations. From the analysis of the simulated wave fields and cold plasma motions, we found that the ratio of the wave frequency to He^+ gyrofrequency is a primary factor for transverse energization of cold He^+ ions. As a consequence of the numerical analysis, we suggest that the significant transverse energization of He^+ ions observed by Arase is attributed to H-band EMIC waves excited near the local helium gyrofrequency.

09:15 [II-1-2]

Characteristics of Mesospheric Gravity Waves over the Korean Peninsula Analyzed by KASI Meteor Radar and TIMED/SABER Data

Hosik Kam[1], Young-Sil Kwak[1,2], In-Sun Song[3], Tae-Yong Yang[1], Byeong-Gwon Song[3], Jeongheon Kim[1], Jaewook Lee[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Yonsei University*

The specular meteor radar (MR) located in Gyeryong (36.2°N, 124.1°E) and operated by KASI observes the under-dense meteor trails and their radial velocities in the mesosphere and lower thermosphere (MLT) region. The radial velocity of meteor echoes is determined by measuring Doppler shift and temporal variation of the phase in the back-scattered signal, and it is estimated using a least-squares linear fit to the phase time series. Typically, radial velocity reserves as a powerful tool for estimating the mean flow in the MLT region. Additionally, the perturbed radial velocity is considered to be influenced by gravity waves, and this conceptional quantity is used to calculate the gravity wave momentum flux. In this study, we derived and verified the gravity wave momentum flux for 5 years (2018–2022) from KASI MR. In addition to this, we examined the atmospheric conditions in the lower atmosphere during the same period using MERRA2-reanalysis data, and compared the activity of gravity waves derived from MR with gravity wave potential energy obtained from SABER data to assess seasonal variations. In addition, we investigated the

characteristics of mesospheric gravity waves by deriving the vertical wavelength from the SABER temperature profiles. We will present our findings on the characteristics of gravity waves over the Korean Peninsula.

09:30 [II-1-3]

Simultaneous Occurrence of Substorm and Pseudosubstorm

Yukinaga Miyashita[1,2], Madeeha Talha[1,2,3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Karachi, Pakistan*

Our previous studies showed that the auroral onset arc associated with a substorm develops in at least three steps. After initial auroral brightening, the onset arc extends longitudinally while its weak wavelike structure gradually grows. The onset arc then enhances further and its wavelike structure also grows more rapidly. Finally, poleward expansion begins. On the other hand, the pseudobreakup (pseudosubstorm) is similar to the early stage of the substorm onset arc development but subsides without proceeding to poleward expansion. Pseudobreakups often occur separately before a substorm, but the separate occurrence does not necessarily seem to be the case. Here, using Time History of Events and Macroscale Interactions during Substorms (THEMIS) data, we show substorm events in which a substorm auroral onset arc and a pseudobreakup arc appeared and developed simultaneously. While a substorm onset arc is developing, an auroral arc very similar to a pseudobreakup also appears and develops for some substorm events. We interpret this arc as a pseudobreakup arc. The pseudobreakup arc appeared either just equatorward or just poleward of the substorm onset arc. Such events are not rare, that is, they occurred for 20% of our selected substorm events. We will discuss the magnetotail processes associated with simultaneous substorm and pseudobreakup events.

09:45 [II-1-4]

Observations of the Solar Corona during the 2024 Total Solar Eclipse

Heesu Yang, Suchan Bong, Young-Beom Jeon

Korea Astronomy and Space Science Institute

The total solar eclipse is a unique and rare chance to observe the fine structures of the solar inner corona. During the total solar eclipse on April 8, 2024, we observe the K-, F-, and E-Corona simultaneously using the CORonal Integral Field Spectropolarimetry (CORIFS) and the SOlar Coronal Multi-slit SPECtropolarimetric Telescope (SOMSPECT). In this presentation, we will report on the development of these instruments and present the preliminary results of our observations..

10:00 [II-1-5]

Preliminary Simulation Results for Ionospheric Responses during the April 8, 2024 Solar Eclipse

Jeong-Heon Kim[1], Young-Sil Kwak[1,2], Hosik Kam[1], Jaewook Lee[1,2], Tae-Yong Yang[1], Jongil Jung[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

On April 8, 2024, a solar eclipse traverses the U.S. mainland, offering a unique opportunity to study ionospheric responses. This study examines the ionospheric impacts of the solar eclipse on April 8, 2024, focusing on the U.S. To identify ionospheric depletions during this event, various instruments such as ionosondes from multiple locations, Millstone Hill ISR altitude profiles, and GPS TEC data are employed. Meanwhile, to compare simulation model results with observational data, the physics-based ionospheric theoretical model, KIPM (Korea Ionospheric Prediction Model), is adapted to specifically target the North American continent. Most importantly, for simulating the reduction in solar irradiance caused by the eclipse, the study by Huba et al. (2017) is referenced, assuming that only 15% of the total solar irradiance (the amount of EUV radiation from the solar corona) contributes to the ionosphere at the eclipse totality region. This presentation shows the assessment of the ionospheric model in replicating the ionospheric dynamics during the eclipse, thereby contributing to a better understanding of ionospheric behavior under such unique solar conditions.

10:15 [II-1-6]

Analysis of the Time-Distance Helioseismic Subsurface Flow for Active Region 13500

Bogyeong Kim[1], Sung-Hong Park[2], Yu Yi[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

Time-Distance Helioseismology is known as a part of local helioseismology, investigating the three-dimensional structure and flow beneath the solar surface to infer the birth and evolution of active regions within the Sun. To understand the changes occurring very close to the surface of active regions in the photosphere, we analyzed the subsurface flow velocity and sound speed below the surface of Active Region AR13500 on the changes over three days, from depths of 0–35 (Mm), and examined the characteristics of subsurface flow velocity below the surface near AR13500. From November 24, 2023, for three days, we investigated the time variation of x-y plane flow velocity, vertical velocity (Vz), and sound-speed perturbation

for each of the 11 layers into which the subsurface depth of 0–35 (Mm) was divided. AR13500 appeared as a delta-type sunspot, already formed from the east limb on November 24, 2023. Subsurface flow was observed from a depth of 17 (Mm) out of the total 35 (Mm). Upward flow represented by vz showed strong rising flows from the 5–7 (Mm) depth range to the 1–3 (Mm) depth range. Plane flow for each layer showed a strong divergence centered around the 5–7 (Mm) neutral line from the 7–10 (Mm) depth range, but from the 3–5 (Mm) depth range to the 1–3 (Mm) depth range, it exhibited a converging pattern towards the neutral line. This study focuses on investigating the subsurface flow beneath the photosphere of an already developed delta-type active region. Hence, based solely on the observation results of one sunspot, it is not possible to determine the physical mechanisms of internal flow, the magnetic flux formed within sunspots, and their evolutionary processes. However, in the future, we plan to classify sunspots into Hale-type and compare their subsurface flow characteristics, as well as analyze the characteristics of the initial and decay stages of sunspot formation.

제2발표장 Convention B

II-2 우주탐사 I

Chair: 홍승범(항우연)

09:00 [II-2-1]

Results of Space Environmental Tests for the GrainCams EQM Payload for a CLPS Lunar Rover

Woojin Kim[1,2], Bongkon Moon[1,2], Dukhang Lee[1], Dae-Hee Lee[1], Minbae Kim[1], Minsup Jeong[1], Jihun Kim[1,2], Sung-Joon Park[1], Yunjon Kim[1,2], Seonghwan Choi[1], Jehyuck Shin[1], Mingyeong Lee[1,2], Chae Kyung Sim[1,2], Young-Jun Choi[1,2], Sungsoo S. Kim[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Univesity of Science and Technology*
[3]*Kyung Hee University*

GrainCams is being developed by KASI as one of the candidate payload for the Commercial Lunar Payload Services (CLPS) of NASA. It consists of two cameras: SurfCam and LevCam. SurfCam is designed to get three-dimensional images of micro-structure on the lunar regolith, known as fairy castle structures. LevCam is to detect levitating or lofted dust grains above the lunar surface.

GrianCams will be exposed to harsh environments when delivered to the moon with the launcher/lander or operating on the moon. In order to ensure reliability of GrainCams, space environmental tests are essential, including the Electro-Magnetic Interference (EMI), Total Ionizing Dose (TID), vibration/shock, and thermal-vacuum test. In this paper, we present the results of the environment tests along with an evaluation of the optical systems' performance, measuring the Modulation Transfer Function (MTF).

09:15 [II-2-2]

In-Flight Calibration Study of KMAG Measurement Data

Hyeonhu Park[1], Ho Jin[1], Wooin Jo[1], Kwan-Hyuk Kim[1], Ian Garrick-Bethell[2], Alex Paul Hoffmann[3]

[1]*School of Space Reseach, Kyung Hee University*
[2]*University of California, Santa Cruz*
[3]*University of Michigan, Ann Arbor*

The Korea Pathfinder Lunar Orbiter (KPLO, also known as Danuri) is now orbiting the Moon at an altitude of 100 km ± 30 km. The measurement data of KPLO MAGnetometer (KMAG) includes the Moon's magnetic field, ambient field, instrument offset, and spacecraft field generated by many unavoidable magnetic field sources. To obtain an accurate natural magnetic fields, it is necessary to remove the slightly changing instrument offset and some periodic spacecraft field in each orbit. In this paper, we present the results of removing an offset and the magnetic spacecraft noises from the measurement data. We use the Davis-Smith and offset cube methods to obtain zero offset, and the Wavelet-Adaptive Interference Cancellation for Underdetermined Platforms (WAIC-UP) technique to remove noises. In addition, we utilize the surface vector mapping (SVM) data (for the lunar crust magnetic filed) and ARTEMIS P1 (Themis-B) magnetometer data (for the ambient field) to verify the corrected data with these methods. Although the exact offset determination and noise removal steps are still remain, we expect that these methods used in this study are applicable to the generation of calibration (CAL) data to be uploaded to KARI Planetary Data System (KPDS).

09:30 [II-2-3]

Contributions of LSMAG Instrument to the Lunar Lander

Juhyeong Kim[1], Ho Jin[1], Seungmin Lee[1], Hyeonhu Park[1], Yunho Jang[1], Hyeonji Kang[1], Junhyun Lee[2], Wooin Jo[1], Hyojeong Lee[3], Seongwhan Lee[3], Young-Jun Choi[4,5], Chae Kyung Sim[4,5], Dukhang Lee[4], Seul-Min Baek[4], Jehyuck Shin[4]

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University
[3]*NARA Space Technology*
[4]*Korea Astronomy and Space Science Institute*
[5]*Korea National University of Science and Technology*

The Lunar Surface MAGnetometer (LSMAG) is an instrument designed to investigate the lunar surface environment. Its development is based on an international collaboration between KASI and NASA as part of the Commercial Lunar Payload Services (CLPS) program.
LSMAG is equipped with two types of magnetometers: two FluxGate Magnetometers (FGMs) and one Anisotropic Magneto-Resistive (AMR) sensor. The resolution of the FGMs is 0.2 nT, with a measurement range of ± 2,000 nT. The AMR sensor can measure stronger magnetic fields (up to ± 80 μT). By using these multiple sensors, we can enhance noise removal methods. LSMAG includes an accelerometer to measure the attitude of the system and sense system vibration. It is also capable of detecting moonquakes. Additionally, if small solar cells are placed around the payload, heading direction can be obtained. This means that if the lander encounters a problem during the landing sequence, LSMAG can assist the lander activities by providing the accelerometer (attitude) data, heading data, and magnetic field data.
As a result, LSMAG can contribute to the possibility of providing this payload information in the event of an emergency for the lander. This concept not only fulfills the scientific mission of the payload, but also enhances the lander's operational capability. Considering this multi-functional capability of the payload instrument with the lander, it will further improve lunar landers' operational reliability.

09:45 [II-2-4]

Initial Estimation of Electrical Conductivity of the Uppermost Layer of the Moon on the Farside with KPLO Magnetometer

Wooin Jo[1], Ian Garrick-Bethell[2], Ho Jin[1], Shahab Fatemi[3], Andrew Poppe[4], Hyeonhu Park[1], Khan-Hyuk Kim[1]

[1]*Kyung Hee University*
[2]*University of California, Santa Cruz, USA*
[3]*Umea University, Sweden*
[4]*University of California, Berkeley, USA*

The electrical conductivity of the lunar interior offers insights into its formation and evolution. This study employs electromagnetic (EM) sounding to investigate lunar electrical conductivity by measuring the induced magnetic field response during transients in the solar wind magnetic field. Emphasis is placed on the lunar farside, given prior reliance on nearside observations from the Apollo era for the global conductivity profile. To measure the lunar induced response on the farside, we use KMAG observations from the Korea Pathfinder Lunar Orbiter (KPLO), which orbits the Moon at an altitude of 100 ± 30 km. Additionally, we utilize two ARTEMIS spacecraft in highly elliptical lunar orbits as references for the interplanetary magnetic field (IMF) background. Accounting for lunar wake fields at KPLO's higher altitude, we employ the AMITIS hybrid-kinetic plasma physics code, integrating plasma parameters and background magnetic field data from ARTEMIS with multi-layer conductivity Moon models. Results indicate that the Moon model with a conductive layer captures both the wake effect and induced fields from the mantle, matching KPLO observations effectively, in contrast to the fully resistive Moon model. Initial conductivity estimates for the upper mantle suggest higher values compared to previous research, implying varied interpretations of lunar subsurface conductivity differences.

10:00 [II-2-5]

Spectral Modeling of Apollo Soil 10084 Based on Grain Size

Eunjin Cho[1], Chae Kyung Sim[2,3], Minsup Jeong[2], Young-Jun Choi[2,3], Yu Yi[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

The Hapke radiative transfer model is a commonly used tool in planetary science for analyzing particulate surfaces. It uses parameters like mineral component abundance, submicroscopic metallic iron particle (SMFe) abundance, and regolith grain size to simulate bidirectional reflectance. Here, we present the procedure for modeling reflectance using available sample information from Apollo soil 10084. Reflectance spectra of Apollo soil 10084, obtained from NASA's Reflectance Experiment Laboratory (RELAB), are provided for various size groups ranging from 0–25 μm to 0–1,000 μm. We compare the modeled reflectance with these spectra, extract grain sizes, and validate our results by comparing them to the size range of the seized sample groups.

10:15 [II-2-6]

Effectiveness of Lunar Regolith as Shielding Material on the Surface of Moon against GCR and Secondary Radiation

Lasany Arfin Kunja[1], Eojin Kim[1], Jongdae Sohn[2], Yu Yi[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

The moon is the most reasonable candidate for habitation since it is the second most frequently observed celestial body after

Earth. The radiation generated from the combination of GCR, and SPE (albedo radiation) on the surface of the Moon is one of the hardest challenges of all due to its thin atmosphere and weak magnetic field. Lunar regolith is a very practical solution for providing sufficient shielding for long-term space journeys that protect future astronauts from radiation. A number of experiments have shown that Geo-Polymar shielding from lunar regolith is good for protection from lunar radiation. A narrow block made of lunar regolith (in our case, only 1 meter or less) is sufficient and it could save the amount of unnecessary labor associated with bringing building materials to the moon. The inside wall of the regolith-built housing model will be covered with several materials which are rich in hydrogen, which have shown remarkable performance in previous study as shielding material on the surface of Mars. It creates a barrier and extra protection between the interior of the housing and the slightly harmful lunar regolith. For the purpose of this study, we ran Monte Carlo simulations of the adsorbed dose to compare the effectivity of some chosen hydrogen-rich materials. The GEANT-4-based simulations were conducted in MULLASSIS, which is integrated within the SPENVIS system. In addition, information was generated in an independent second approach using the On-Line Tool for the Assessment of Radiation in Space, or OLTARIS. For both simulations, the Badhwar-O'Neill 2014 Model was implemented. Of the materials tested, LiH performed the best, excelling Kevlar, aluminum, Mylar, polystyrene, and polypropylene by 15%, 14%, 11%, 8%, and 4%, respectively.

제3발표장 Convention C

II-3 SS: L4 관측기기 I

Chair: 한정열(천문연)

09:00 [II-3-1]

Comprehensive Multi-Omics Analysis Approaches Revealed Alteration Mechanisms by Spaceflight

Man S. Kim

Translational-Transdisciplinary Research Center, Clinical Research Institute, Kyung Hee University Hospital at Gangdong, Kyung Hee University College of Medicine

Human space exploration poses inherent risks to astronauts' health, leading to molecular changes that can significantly impact their well-being. These alterations encompass genomic instability, mitochondrial dysfunction, increased inflammation, homeostatic dysregulation, and various epigenomic changes. Remarkably, these changes bear similarities to those observed during the aging process on Earth. However, our understanding of the connection between these molecular shifts and disease development in space remains limited. To reveal these causes, we used a multi-omics, systems biology analytical approach using biomedical profiles from fifty-nine astronauts and data from NASA's GeneLab derived from hundreds of samples flown in space to determine transcriptomic, proteomic, metabolomic, and epigenetic responses to spaceflight. Overall pathway analyses on the multi-omics datasets showed significant enrichment for mitochondrial processes, as well as innate immunity, chronic inflammation, cell cycle, circadian rhythm, and olfactory functions. Importantly, NASA's Twin Study provided a platform to confirm several of our principal findings. Evidence of altered mitochondrial function and DNA damage was also found in the urine and blood metabolic data compiled from the astronaut cohort and NASA Twin Study data, indicating mitochondrial stress as a consistent phenotype of spaceflight.

09:30 [II-3-2]

Open New Horizon with L4 Mission: Vision and Planning

K.-S. Cho[1], J. Hwang[1], E.-K. Lim[1], J.-Y. Han[1], S.-H. Choi[1], J. Seough[1], R.-S. Kim[1], S.-H. Park[1], Y.-S. Kim[1], J.-D. Sohn[1], J.-H, Baek[1], J. -Y. Kwak[1], Y.-J. Moon[2], J. Seon[2], K.-S. Ryu[3], C.-H, Lee[4]

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[3]*Korea Advanced Institute of Science and Technology*
[4]*Korea Areospace Industries*

The Sun-Earth Lagrange point L4 is considered as one of the unique places where the solar activity and heliospheric environment can be observed in a continuous and comprehensive manner. The L4 mission affords a clear and wide-angle view of the Sun-Earth line for the study of the Sun-Earth and Sun-Moon connections from he perspective of remote-sensing observations. In-situ measurements of the solar radiation, solar wind, and heliospheric magnetic field are critical components necessary for monitoring and forecasting the radiation environment as it relates to the issue of safe human exploration of the Moon and Mars. A dust detector on the ram side of the spacecraft allows for an unprecedented detection of local dust and its interactions with the heliosphere. The purpose of the present paper is to emphasize the importance of L4 observations as well as to outline a strategy for the planned L4 mission with remote and *in-situ* payloads onboard a Korean spacecraft. It is expected that the Korean L4 mission can significantly contribute to improving the space weather forecasting capability by enhancing the understanding of heliosphere through comprehensive and coordinated observations of the heliosphere at multi-points with other existing or planned L1 and L5 missions.

09:45 [II-3-3]

Preliminary Concept Design Result of Space Probe for L4 Mission

Hwayeong Kim[1], Hyeon-Jeong Park[1], Jaehwee Doh[1], Jong-Jin Jang[1], Chang-Han Lee[1], Hyun-Suk Seo[1], Kyung-Suk Cho[2]

[1]*Korea Aerospace Industries, Ltd.*
[2]*Korea Astronomy and Space Science Institute*

On July 27th 2023, Korea Aerospace Industries (hereinafter referred to as KAI) and Korea Astronomy and Space Science Institute (hereinafter referred to as KASI) entered into a business agreement to enhance cooperation in space exploration. As follow-up, KAI and KASI are operating to establish joint research task force for L4 mission spacecraft development and lead the way in advanced deep space exploration technology. This paper briefly introduces the key achievements of the TF team operating during the second half of 2023.
Through the operation of the TF team, KAI and KASI completed the conceptual design of a space probe that can accommodate a number of remote and *in-situ* observation payloads to perform mission in Lagrangian Point 4 (L4) and based on this, a space probe design plan was derived. The derived preliminary spacecraft design will be optimized by reflecting future mission operation concepts, system development requirements and payload design specifications.

10:00 [II-3-4]

Scientific Suggestions of the Heliophysics L4 Mission by Remote-Sensing Observations

Yong-Jae Moon[1], Kyung-Suk Cho[2], Sung-Hong Park[2], Eun-Kyung Lim[2], Roksoon Kim[2], Donguk Song[2], Jongyeob Park[2], Eunsu Park[2], Harim Lee[1], Hyun-Jin Jeong[1], Jihye Kang[1], Il-Hyun Cho[1], Hyeonock Na[1], Jinhye Park[1], Kangwoo Yi[1]

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[2]*Korea Astronomy and Space Science Institute*

The Sun-Earth Lagrange point L4, which is called a parking space of space, is considered one of the unique places where solar activity and heliospheric environment can be observed continuously and comprehensively. The L4 mission affords a clear and wide-angle view of the Sun-Earth line for the study of the Sun-Earth connections from remote-sensing observations. The L4 mission will significantly contribute to advancing heliophysics science, improving space weather forecasting capability, extending space weather studies far beyond near-Earth space, and risk reduction from solar radiation hazards on human missions to the Moon and Mars. Our paper outlines the importance of L4 observations by using remote-sensing instruments and advocates comprehensive and coordinated observations of the heliosphere at multi-points including other planned L1 and L5 missions. We mainly discuss scientific perspectives on three topics in view of remote sensing observations: (1) solar magnetic field structure and evolution, (2) source regions of geoeffective solar energetic particles (SEPs), and (3) stereoscopic views of solar corona and coronal mass ejections (CMEs).

10:15 [II-3-5]

Chromospheric Imaging Spectrograph for L4 Mission: Status and Plans

Eun-Kyung Lim, Donguk Song, Jeong-Yeol Han, Sung-Hong Park, L4 Team

Korea Astronomy and Space Science Institute

The scientific goal of the Chromospheric Imaging Spectrograph for the L4 mission is to investigate early dynamic signatures of a filament/prominence eruption well before its typical rising phase, during which the rising speed of the filament accelerates. Coronal Mass Ejections are known to be causally related to space-weather hazardous solar energetic particle (SEP) events, and they are often preceded by filament/prominence eruptions. Understanding the physical nature of filament/prominence eruption is crucial not only for space-weather forecasting but also for comprehending the physical mechanisms underlying solar eruptions. Given this scientific goal, the basic requirements for the telescope include a full-disk field of view, wide wavelength coverage of ± 0.65 nm for the Hα line, 0.02 nm spectral sampling, and 2-arcsec spatial sampling, among others. In this presentation, we will review both the scientific and observational requirements of the planned chromospheric imaging spectrograph and share the current status and future plans of the feasibility study on the instrument.

제1발표장 Convention A

III-1 태양 및 우주환경 III

Chair: 김수진(천문연)

10:40 [III-1-1]

Study on the Diurnal Variation of Cosmic Ray Intensity at Jang Bogo Neutron Monitor in Antarctica

Jongil Jung[1], Suyeon Oh[2], Young-Sil Kwak[1], Yu Yi[3], Geonhwa Jee[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chonnam National University*
[3]*Chungnam National University*
[4]*Korea Polar Research Institute*

The diurnal variation of cosmic ray intensity, which can be observed in cosmic ray neutron monitor, is related to the anisotropy in cosmic rays reaching the Earth. The diurnal variation of cosmic ray intensity is the result of complex phenomenon related to interplanetary magnetic field and magnetosphere. Additionally, it depends on the location on the Earth, i.e. latitude, longitude and altitude. The diurnal variation has an average amplitude of about 1–2%, and this amplitude can vary with the solar activity. For example, when the Forbush decrease caused by solar eruptions occurs, the amplitude of the diurnal variation can change by up to 5%. We examine the characteristics of the diurnal variation of neutron monitor at Jang Bogo station in Antarctica. The Jang Bogo neutron monitor has been in operation since 2015. We also analyze seasonal variation of cosmic ray. Our study aims to increase the understanding of cosmic ray characteristics around Jang Bogo station.

10:55 [III-1-2]

Aurora Observations by Korean Automated Geophysical Observatoty (KAGO) at Cape Hallett, Antarctica

Hyuck-Jin Kwon[1], Changsup Lee[1,2], Geonhwa Jee[1,2], Young-Bae Ham[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

The Korea Polar Research Institute (KOPRI) has been operating visible and filter All-Sky Camera (ASC) at Jang Bogo Station (JBS) since 2017 and 2022, respectively. However, due to the location of JBS, the aurora observations from JBS have been confined to the cusp or boundary of polar cap. In order to expand the observation coverage, we propose to install ASC-network named as Korean Automated Geophysical Observatory (KAGO). In this paper, we introduce the KAGO system and initial observations of aurora at Cape Hallett (geographic: 72.32°S, 170.23°E, geomagnetic: 77.16°S, 60.69°W), which is situated at a lower latitude than JBS.

11:10 [III-1-3]

Investigating Energy Spectra of Energetic Electrons and Protons in Soalr Energetic Particle Events

Ji-Hyeon Yoo[1,2], Ryun-Young Kwon[1], Dae-Young Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungbuk National University*

We present different types of energy spectra of Solar Energetic Particles (SEPs) observed at 1 AU. Our study uses data taken from WIND, the Solar and Heliospheric Observatory (SOHO), and the Solar TErrestrial RElations Observatory spacecraft (STEREO-A and STEREO-B). The energy spectra are constructed using both energetic electrons and protons observed across various energy channels and are investigated by visual inspection. We demonstrate that these spectra can be categorized into three distinct types: those showing a sudden increase in flux at all energies, those with flux increasing sequentially from high to low energy, and those exhibiting the opposite trend, from low to high energy. The category showing the sudden increase predominates for energetic protons above 1 MeV, while the other two categories occur similar levels. Some energy spectra appear complicated, with electrons and protons in an energy spectrum falling into different categories. We provide analyses of flares and coronal mass ejections associated with these SEP events and establish connections between these solar events and the different types of energy spectra.

11:25 [III-1-4]

Extreme Ionospheric GNSS Scintillation Events over Korean Peninsula on November 5, 2023

Junseok Hong[1], Byung-Kyu Choi[1], Jong-Kyun Chung[1], Woo Kyoung Lee[1], Hyosub Kil[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Johns Hopkins University Applied Physics Laboratory*

The ionospheric electron densities can be fluctuated in temporal and in spatial due to both electromagnetic effects and neutral atmospheric component changes. The irregular ionospheric density distribution can damage to Global Navigation Satellite System (GNSS) signals, and it leads to degradation of GNSS-based infrastructure performances. These ionospheric irregularities are frequent in low- and high-latitudes. Meanwhile, mid-latitudes are regions where ionospheric activity is relatively less compared to other latitudes. Very small amplitude fluctuations such as medium scale traveling ionospheric disturbances are often observed in mid-latitudes, but their effects on the ionosphere are too subtle so they are not critical to GNSS users. However, the high concentration of people in mid-latitudes amplifies the importance of studying ionospheric activity and its effects. Severe ionospheric GNSS scintillation events occurred at Korean peninsula on November 5, 2023, and these lasted about 3 hours. Unusually extreme GNSS scintillations occurred in multi GNSS constellations and also occurred in satellite based augmentation system signals. Strong electron density fluctuations were also detected by *in-situ* measurements from satellite. Equatorial ionization anomaly structure were also

collapsed on the event date. This event implies that the mid-latitude region is not safety area from the severe ionospheric disturbances, so the ionospheric researches including monitoring and forecasting systems in mid-latitudes are important. We will present the results and discuss possible mechanisms.

11:40 [III-1-5]

Diverging Destinies of Twin Solar Energetic Particle Events

Hae-In Lee[1,2], Ryun-Young Kwon[2]

[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*

It has been well known that solar energetic particles (SEPs) are accelerated by magnetic reconnection in solar flares and shocks driven by and coronal mass ejections (CMEs). Nevertheless, the interpretation of observed SEP properties in the distant interplanetary space, far from the Sun, remains a subject of ongoing debate and lacks comprehensive understanding. This is primarily attributed to the diverse characteristis of magneitc reconnections and shocks at the site of the acceleration, as well as the intricate transport processes during particles travel through the interplanetary medium. In this paper, we present twin SEP events where the proton flux profiles are similar, to minimize the impact of diverse variables arising from the acceleration and transport processes. We have inspected data from both STEREO-A and STEREO-B during the ascending phase of Solar Cycle 24, from January 2007 to August 2014, and selected 47 proton enhancement events. Among these events, we investigate the properties of twin SEP events and compare them with the properties of parent solar events. We also conduct the reverse comparison by identifying CMEs with similar geometric and kinetic characteristis. We discussed the separate roles of shocks, transport processes, and the ambient medium in influencing the observed properties of SEPs.

11:55 [III-1-6]

A Study on the Occurrence Characteristics and Sources of Daytime Ionospheric Irregularities in the Mid and Low Latitudes of the East-Asia Region

Hoang Ngoc Huy Nguyen[1,2], Young-Sil Kwak[1,2], Woo Kyoung Lee[1,2], Hyosub Kil[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Johns Hopkins University Applied Physics Laboratory*

In this study, we investigate seasonal and longitudinal variations in daytime ionospheric irregularities by analyzing total electron content (TEC) over the East Asian region during a period of low solar activity (2017–2021). To derive perturbation components of TEC, we subtracted the 1-hour running average from the TEC time series for each satellite-receiver pair. Seasonal variation of perturbation was quantified as the ratio of perturbation's standard deviation to a 1-hour average of vertical TEC. Our findings indicate consistent peaks in GPS TEC daytime perturbation during winter across all studied years, aligning with Medium-Scale Traveling Ionospheric Disturbance (MSTID) activity in this region. To better understand the source and characteristics of daytime ionospheric irregularities in the East Asian sector and their relationship with MSTIDs and plasma bubbles, we compare our results with ICON satellite observations from 2020–2021. On the contrary, satellite observations of low-latitude daytime ionospheric disturbances during the low solar activity period (2020–2021) reveal peak electron density irregularities during the summer solstice in the East Asia sector. This discrepancy may stem from the height dependence of the source of the ionospheric disturbance source. It's possible that at lower altitudes, MSTIDs have a more pronounced effect and are a primary source of irregularities, whereas at altitude over 600 km, plasma bubbles can override the influence of MSTIDs on the iopnospheric irregularity within that altitude range.

제2발표장 Convention B

III-2 우주탐사 II / 우주천문

Chair: 조은진(충남대)

10:40 [III-2-1]

Global Lunar Exploration Status and Analysis

Yong-Sik Yoon, Jong-Min Im, Hee-Kwang Eun

Korea Aerospace Research Institute

In the 4th Space Development Promotion Plan (draft) announced in December 2022, Korea plans to secure its own core capabilities to take the lead in manned and unmanned activities on the Moon and Mars by 2045. The early stages of lunar exploration by the United States and the Soviet Union experienced many failures. Recently, with technological stabilization, the United States, China, Russia, ESA and Japan, etc. are competitively conducting lunar exploration. And types of lunar exploration can be divided into lunar orbiters, landers, flyby and manned spacecraft. This paper briefly seek to organize and analyze the exploration situation by country, mission and period.

10:55 [III-2-2]

Flagship Program and Roadmap Research for

Domestic Space Science, Exploration and Utilization

Gi-Hyuk Choi, Dae-Yeoung Kim, Joo-hee Lee, Yeongyu Kim, Seoyoung Jeong

Korea Aerospace Research Institute

With the success of the Korean launch vehicle in 2022, the Republic of Korea entered the space advanced country equipped with satellite and launch vehicle technology. Accordingly, we are at a point where we need to evolve from a focus on satellite and launch vehicle hardware system development to a space development 2.0 focus on mission development for space science, space exploration, and space utilization. In particular, domestic space development is expected to gain significant momentum as the Governmental Korea Aero Space Administration (KASA) is scheduled to be established at the end of May this year. In addition, the 4th Space Development Promotion Basic Plan, announced in December 2022, aims to realize a space economic powerhouse by promoting space industrialization by 2045, and aims to create 10% of the global space market and 250,000 jobs by then.

In order to achieve this goal, the development of the existing next-generation launch vehicle (KSLV-3), the Arirang Earth Observation Satellite (KOMPSAT), and the Geostationary Orbital Satellite for Meteorological Observation and Communication and Ocean Observation (GEOKOMPSAT) must be thoroughly pursued. In parallel, space science, space exploration, and space utilization must be actively promoted. This mission-oriented space development requires a strategic approach and must have scientific importance, progress in space technology, and international contribution. In addition, it should help the domestic space economy and job creation, as well as public convenience and security. For the efficient business promotion and public promotion, a central program that can attract the public's attention, that is, a flagship program, must be introduced. Space science will focus on the 2 m diameter aperture space telescope project, but will also promote research on the upper atmosphere, ionosphere, and heliospheric environment. For space exploration, participation in the manned lunar exploration Artemis is promoted. We propose to focus on the Lunar Cargo Return (LCR) mission, which transports cargo and lunar sample between the moon and Earth orbit. The LCR program encompasses core space technologies such as deep space navigation, high-capacity propulsion, rendezvous docking, on-orbit refueling, atmospheric re-entry, and lunar takeoff and landing, and is also an area in which NASA hopes Korea would participate. The previously confirmed Lunar Lander (KLL, '32) would be better to monitor the lunar environment for a year and surveying resources, including water, on the lunar surface to support the mission of the manned lander. On the lunar surface, NASA proposes the development of backup life support systems, lunar-Earth communication, lunar mobility with vehicles and robots, and small nuclear power modules (SMRs). To operate this, a Korean astronaut should land on the lunar surface in the late 2030s. Mars exploration will also be conducted with international cooperation on orbiters ('30s), landers ('45), and surface activities, with a 10-year later from lunar exploration. Space utilization will center on space experiments, space material production, and artificial organ (Organoid) production in microgravity environment at the Low Earth Orbit (LEO) space station. In order to proceed with this, a second astronaut must be selected and perform space flights in the 20s.

In order to successfully pursue the above space development roadmap, a flagship program that attracts national attention is essential, national philosophy and strategy must be established first, and leadership from the Aerospace Administration is required. Also national selection and focus must be made to establish an total power system of industry-academia-government.

11:10 [III-2-3]

Efficient Preliminary Design of Low-Thrust Interplanetary Trajectories Involving Gravity Assists Using Shape-Based Intercept Arcs

Pureum Kim, Sang-Young Park

Yonsei University

In low-thrust trajectory design, obtaining good preliminary trajectories can profoundly contribute to the fine design of optimal and/or high-fidelity trajectories suitable for real-world missions. This also holds true for low-thrust interplanetary trajectory design problems, which can become further complicated with the introduction of gravity assists. This study explores the preliminary design of such low-thrust, gravity-assisted (LTGA) trajectories using a shape-based (SB) method. In this approach, each low-thrust arc constituting an overall trajectory is designed by an SB method based on finite Fourier series as an inner arc solver. The outer problem, which involves finding good boundary conditions for the arcs for the purpose of minimizing the overall fuel consumption, is solved by a global optimization algorithm. In this two-level solving strategy for LTGA problems, the outer problem complexity can be diminished when the inner arcs are solved as intercept-type problems (instead of rendezvous-type problems), at the expense of constraining the feasible solution space. We propose two outer problem models for the LTGA problem that rely on the use of intercept arcs, and apply them to a few interplanetary missions to near-Earth small bodies as example cases. Comparisons of solution optimality and computational burden are drawn between different problem models to demonstrate the efficiency of the newly proposed problem models.

11:25 [III-2-4]

Classification of Subgroups within the SOHO Sungrazing Kreutz Comet Group Using the DBSCAN Clustering Algorithm and Analysis of Asymptotic Incoming Directions

Ulkar Karimova, Yu Yi

Chungnam National University

Sungrazing comets, a unique subset of comets characterized by their close proximity to the Sun, can be classified into various groups and subgroups based on their distinct features. This research focuses on the SOHO Kreutz comet group and aims to develop a practical and automated classification method using the DBSCAN algorithm. The efficacy of this approach is supported by scatter matrix plots and heliographic mapping and direction tests. Furthermore, the proposed classification technique enhances our understanding of these comets, facilitating investigations into their potential origins and asymptotic directions within the group. This study offers valuable insights into the origins and dynamics of the Kreutz comet cluster within the solar system, presenting an alternative framework for comprehending their formation processes.

11:40 [III-2-5]

Verifying Observation Records of Comet C/1652 Y1 from Korean Chronicles

Byeong-Hee Mihn[1,2,3], Ki-Won Lee[4],
Uhn Mee Bahk[2], Sang Hyuk Kim[1]

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[2]*Chungbuk National University*
[3]*University of Science and Technology*
[4]*Daegu Catholic University*

Korean observations of comet C/1652 Y1, referred to as *Baekseong* (white star, in literal) or *Gaekseong* (guest star, in literal), span from December 19, 1652 to January 9, 1653. These observations with the naked eye are recorded in the *Hyojongsillok* (Veritable Records of King Hyojong), *Seungjeongwon-Ilgi* (Daily Records of Royal Secretariat), and *Donggung-Ilgi* (Daily Records of Royal Education Office for Crown Prince) of King Hyeonjong, and have 13, 20, and 9 observational records, respectively. This study introduces detailed observational records of comet C/1652 Y1 documented in Korean histories. Moreover, we compare these observations with the orbital path calculated using the orbital elements provided by Marsden in 1983 and the illustrations depicted by Weigelius and Schiltero in 1653 and Hevelius in 1668. The Korean observations show discrepancies with Marsden's orbital path and Weigelius and Schiltero's illustration but agree with Hevelius's, particularly near the end of the observation period.

11:55 [III-2-6]

Development of Armillary Clocks and Alarm Clocks in Korea: From the Mid-17th Century to the Mid-19th Century

Sang Hyuk Kim[1], Kyoung Uk Nam[2],
Byeong-Hee Mihn[1,3,4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Gwacheon National Science Museum*
[3]*Chungbuk National University*
[4]*Korea University of Science and Technology*

In the 17th century Joseon, Song I-Yeong (1619–?) created one of the most remarkable armillary clocks, employing a weight-driven power source to accurately replicate the movements of the sun and moon. He innovated within this field by integrating Borugaknu's time-keeping mechanism with a unique bell-striking feature, thus enhancing the functionality of the armillary clock. Subsequently, Hong Dae Yong (1731–1783) further advanced celestial movement mechanisms, leading to the development of an improved armillary clock. The escapements in the clocks designed by Song and Hong were, respectively, the pendulum and the foliot. Moving into the 19th century, Nam Byeongcheol (1817–1873) shed light on the Heomsiui (a time-checking instrument, alarm clock) in his Uigijipseol (the Collection of Writings on Scientific Instruments). This clock device utilized a pendulum escapement and incorporated a lacquer-and-snail striking mechanism, showcasing advancements in timekeeping. This study explores the evolution and technological progress of armillary and alarm clocks in Korea, emphasizing significant innovations throughout their development.

제3발표장 Convention C

III-3 SS: L4 관측기기 II

Chair: 문용재(경희대)

10:40 [III-3-1]

L4 Mission: Conceptual Opitcal Design for H-Alpha Imaging Spectrograph

Hyoung-Kwon Lee[1], Jae-Hyun Kyeong[1],
Eun-Kyung Lim[2], Jeong-Yeol Han[2,3], Donguk Song[2],
Sung-Hong Park[2], Kyung-Suk Cho[2],
Seong-Whan Choi[2], Roksoon Kim[2], Jiwoo Lee[2,3]

[1]*LeO SPACE Inc.*
[2]*Korea Astronomy and Space Science Institute (KASI)*
[3]*University of Science and Technology (UST)*

The Korea Astronomy and Space Science Institute (KASI) is conducting a mission to establish a heliospheric observatory at the Lagrange point L4, to continuously monitor solar magnetic activity and changes in heliospheric space weather. In this presentation, we report the conceptual optical design for the H-alpha imaging spectrograph. The requirements of the H-alpha imaging spectrograph for the scientific mission of the L4 probe include a field of view of 36 × 36 arcmin^2, a spatial resolution of 2 arcsec, and a spectral resolution of 0.4Å, presenting us a conceptual design for optical instruments that meet these requirements. Additionally, we will discuss Free Space Optical (FSO) communication as a technical solution for promptly detecting changes in solar activity and efficiently transmitting the large-scale data obtained from solar observations.

10:55 [III-3-2]

Progress on a Feasibility Study of Deploying a Solar Vector Magnetograph for a Future L4 Mission

Sung-Hong Park, Kyung-Suk Cho, Eun-Kyung Lim, Donguk Song, Jeong-Yeol Han, Eunsu Park, Seonghwan Choi, Roksoon Kim, Jongyeob Park, Ji-Hye Baek

Korea Astronomy and Space Science Institute

Since 2023, Korea Astronomy and Space Science Institute (KASI) has been carrying out a feasibility study to develope a heliospheric observatory orbiting the Sun-Earth Lagrange point L4 for innovative solar and space weather research and monitoring. Throughout this study, we identify the mission's primary science objectives as follows: (1) revealing the characteristics of solar source regions that produce solar energetic particles (SEPs), (2) exploring the initiation, acceleration and propagation of the coronal mass ejections (CMEs) from the Sun's low atmosphere to the interplanetary space, and (3) investigating the influence/effects of solar activity on the varying physical conditions in the heliospheric environment. A solar magnetograph aiming to provide full-disk images of the photospheric magnetic field vector is essential for investigating all of the addressed science objectives. Here we present a recent update on scientific requirements of a vector magnetograph particularly designed for the L4 mission under study.

11:10 [III-3-3]

Heliospheric Imager for the Lagrange L4 Mission

Roksoon Kim, Kyung-Suk Cho, Jungjoon Seough, Sung-Hong Park, Eun-Kyung Lim, Junga Hwang, Donguk Song, Jeong-Yeol Han, Seonghwan Choi

Korea Astronomy and Space Science Institute

For human space exploration beyond the Moon to Mars, solar monitoring at point L4 is crucial to ensure the safety of astronauts. Specifically, coronal mass ejections (CMEs), which are magnetized plasma propagating from the Sun into interplanetary space, cause risks of energetic particles and radiation hazards, thus necessitating constant monitoring. While CMEs near the Sun (< 0.15 AU) have been observed using coronagraphs, tracking their journey to the distant heliosphere until they are detected as interplanetary CMEs (ICMEs) through *in-situ* observation of solar wind disturbances is challenging. A heliospheric imager, similar to a coronagraph observing the solar corona in visible wavelengths with a solar occulter, observes the area from the higher corona to beyond the Earth with a solar occulter and measures density and speed by directly tracking the movement of CMEs. This is the reason why the heliospheric imager is the essential instrument for the heliosphere missions such as the STEREO and the Vigil (L5). In this study, we summarize the scientific mission and instrument requirements of the heliospheric imager for the L4 mission.

11:25 [III-3-4]

Development of EUV Optical Components Machining Technology for L4 Remote Observation

Min-Gab Bog[1], Jin-Seong Jeong[2], Young-Jae Kim[2], Hong-seop Kim[2]

[1]*Hanbat National University*
[2]*Y&DK Co.*

With the announcement of the Future Space Economy Roadmap at the end of 2022, research to advance into space is becoming more active. We provide Diamond Turning Machining (DTM) and Magnetorheological Finishing (MRF) technologies for manufacturing ultra-precision optical components of space satellites. It is developing EUV wavelength optical component localization processing technology that relies on imports due to the absence of ultra-high precision optical component manufacturing technology. so, if the development is completed, it will be a benfit to Korea space optics industry.

One of the reasons it is difficult to manufacture the EUV optical components is that the required accuracy (Form accuracy, Surface roughness, etc.) is sub-nanometer level in accordance with light wavelength shortening.

To solve this issue, we are developing a sub-nanometer level surface process machine using an gas cluster ion beam figuring module. We would like to discuss surface machining technology for application to EUV Imager optical components of the 'L4 Mission' such as EUV cameras (wavelength range: 19.3 nm / 33.5 nm).

11:40 [III-3-5]

Ultra-Precision Machining Technology for Fabrication of Reflective Optics Systems

Geon Hee Kim[1,2], Jong Gyun Kang[2], Joong Kyu Ham[2], Hwan Ho Maeng[2], Seong Hyeon Park[2]

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The Sun-Earth Lagrange Point L4, located in the Earth's orbit 60 degrees ahead of Earth, is a unique point where gravity from the Earth and the Sun cancels out. When an object is positioned at this point, it can maintain a relatively fixed position while orbiting along with the Earth and the Sun. This characteristic allows for more stable space missions with reduced fuel consumption, making it an essential location for celestial observation and exploration. Leveraging the advantages of L4, we conducted research on the development of fabrication technology for reflective optics systems, which are crucial components for space missions. eflective optics systems are utilized as core components of microscopes or payloads for satellites due to their low optical distortion, high resolution, and versatility in focal lengths. Recently, there has been a surge in demand for free-form reflective optics systems made from various materials to construct high-specification optical systems. However, many materials with excellent optical properties exhibit low machinability, necessitating the development of ultra-precision machining technology to address these challenges. In this paper, we investigate ultra-precision machining technology for the fabrication of high-performance reflective optics systems.

제4발표장 Vega Hall

III-4 안보우주 II

Chair: 유지희(ADD)

10:40 [III-4-1]

Suggestion of Space Weather Forecasting Criteria for Military Operations

Ho-Sung Choi

Republic of Korea Army (ROKA)

Modern warfare has been expanded to space as well as cyber domain, and precise guiding munition system has grown up. As a result of the tendency, space weather might effect seriously on military operations as the actual cases are happened in the military operations conducted by US forces. Therefore, ROK air force established space weather team and space weather forecasting system to support operations of weapon systems and reduce space weather affects on military operations. However, ROK DoD has been using civil space weather criteria, not established military space weather criteria. This is not enough for armed forces to execute military operations stably. In this study, space weather criteria of civil and US space forces are examined and the criteria for military operations will be suggested.

10:55 [III-4-2]

Ionospheric Storm Trend Expected in Solar Cycle 25

Jong-Kyun Chung, Junseok Hong, Byung-Kyu Choi, Dong-Hyo Sohn

Korea Astronomy and Space Science Institute

The relationship between ionospheric storms and solar activity, including Solar Cycle 25, is quite significant. Solar Cycle 25 is the 25th cycle of solar activity that the Sun undergoes approximately every 11 years. During this cycle, the Sun goes through periods of increased and decreased activity, characterized by the number of sunspots and solar flare. Ionospheric storm are disturbances in the ionosphere. These storms are often caused by solar events such as solar flares and coronal mass ejections, which release a large amount of energy and particles into space. When these particles interact with the Earth's ionosphere, they can cause disruptions in radio communications, GNSS signals. In this present, We show the ionospheric storm trend in the previous Solar Cycle, and then will predict the tendency of ionospheric storms to occur in Solar Cycle 25 and discuss their impact on GNSS.

11:10 [III-4-3]

AstroLibrary: The Engine for Quick and Easy Development of K-STM

Shawn SH Choi[1,2,3], Junny Joo[1], Yusang Lee[1,4], Peter JH Ryu[1,2], Douglas DS Kim[1,2,3]

[1]*SPACEMAP Inc.*
[2]*Voronoi Diagram Research Center, Hanyang University*
[3]*School of Mechanical Engineering, Hanyang University*
[4]*Department of Computer Science, Hanyang University*

Space Traffic Management (STM) encompasses the comprehensive management of space traffic to ensure the safe, stable, and sustainable use of outer space. This includes monitoring space objects, predicting potential collisions, and coordinating maneuvers to avoid such incidents amid a rapidly expanding space catalogue. AstroLibrary from SpaceMap meets this need by offering a comprehensive set of APIs for the development of K-STM systems, facilitating real-time decision-making in the increasingly congested space environment. With the rise in the

number of satellites and space debris in low Earth orbit, the demand for sophisticated space traffic management solutions is more pressing than ever. AstroLibrary enables real-time conjunction assessment (CA) and near real-time collision avoidance (COLA) for current space catalogues, supporting O (10^4) to O (10^6) or more objects. This is achieved by representing the spatiotemporal proximity among satellites in a concise data structure through preprocessing. The theoretical and computational foundation of AstroLibrary is built on the Voronoi diagram, recognized as the most efficient data structure for spatiotemporal reasoning among objects in 2D and 3D spaces. The library's algorithms are implemented in C++ and are accessible through RESTful APIs and a Python package, allowing application programs to easily tackle challenging spatiotemporal problems. Even those with basic programming skills can develop efficient application programs using AstroLibrary. We envision AstroLibrary as a catalyst for the rapid and straightforward development of K-STM systems. By fostering the creation of robust space traffic management solutions, AstroLibrary plays a vital role in safeguarding the future of our space environment.

11:25 [III-4-4]

K-DRIFT: Off-Axis Freeform Telescope for Optimal Detection of the Low-Surface-Brightness Celestial Objects

Jongwan Ko[1,2], K-DRIFT Team

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

The K-DRIFT (KASI Deep Rolling Imaging Fast Telescope) is an advanced design with three off-axis freeform mirrors, specifically created to study low-surface-brightness (LSB) areas of the universe that are less than approximately 0.1% of the brightness of the night sky seen from the ground. In 2021, a test version called the K-DRIFT Pathfinder was developed and tested at the Bohyunsan Optical Astronomy Observatory over a year. The results showed that the Pathfinder was effective in detecting LSB features, leading to the development of an algorithm to improve the freeform optical system and the LSB imaging process. The technology developed through the K-DRIFT project, which is optimized for observing very dim celestial objects, will have various applications in the realm of space security.

11:40 [III-4-5]

Orbital Decay of Low Earth Orbit Satellite

Byoung-Sun Lee[1,2], Junho Lee[3], Junmo Kim[4]

[1]*Electronics and Telecommunications Research Institute (ETRI)*
[2]*University of Scienct and Technology (UST)*
[3]*Korea Aerospace Industries (KAI)*
[4]*Soletop*

The orbital decay of satellites in low Earth orbit (LEO) occurs gradually due to the faint but persistent resistance of the Earth's atmosphere, resulting in a continuous decrease in altitude and eventually leading to re-entry. Since atmospheric density exponentially decreases with altitude, satellites at lower altitudes can fall back to Earth significantly faster than those at higher altitudes. Spacetrack.org provides orbital data of satellites in the Two-Line Element (TLE) format over time, enabling the analysis of orbital changes for satellites that have been in orbit for an extended period.
This study analyzes the decrease in altitude over time for two South Korean satellites: KITSAT-1 and KOMPSAT-1. KITSAT-1, with its nominal altitude of 1,314 km, is predicted to show minimal altitude change over time. In contrast, KOMPSAT-1, at a nominal altitude of 685 km, is expected to experience a more significant decrease in altitude, especially since its mission ended in January 2008. This research will also forecast the future orbital decay of KOMPSAT-1 post-February 2023 and predict the potential timeline for its eventual re-entry into the Earth's atmosphere.

11:55 [III-4-6]

SNIPE-II Mission

Jaeheung Park[1], Jae-Jin Lee[1], Jongdae Sohn[1], Tae-Yong Yang[1], Hosub Song[1], Young-Joon Jung[1,2], Youngbum Song[1]

[1]*Korea Astronomy and Space Science Institute (KASI)*
[2]*Republic of Korea Army (ROKA)*

The SNIPE mission consists of 4 CubeSats designed to monitor space weather parameters in a controllable formation. The satellites were launched on 25 May 2023 from the Naro Space Center in Korea. Thereafter, SNIPE probed cold ionospheric plasma, magnetic field, and high-energy electrons coming from the radiation belt, and successfully downlinked the data to ground stations in Daejeon (Korea) and Svalbard (Norway). From September 2023 to April 2024, the spacecraft has been firing onboard cold gas thrusters and controlling the inter-spacecraft distance. In this presentation, we first summarize lessons learned from the SNIPE mission. Based on them, we further suggest a new mission, SNIPE-II, as an extension and improvement of SNIPE. We further discuss its possible application to ground surveillance for a military purpose.

제1발표장 Convention A

IV-1 태양 및 우주환경 IV / 위성정보활용

Chair: 홍준석(천문연)

13:30 [IV-1-1]

Assessment of Current Capabilities in Modeling the Ionospheric Climatology for Space Weather Applications: foF2 and hmF2

G. Jee[1,2], J. S. Shim[3,4], I.-S. Song[3], Y.-S. Kwak[2,5], I. Tsagouri[6], L. Goncharenko[7], L. Rastaetter[3], J. Yue[3], M. Chou[3], D. Blitza[8], M. Codrescu[9], M. Fedrizzi[9], T. J. Fuller-Rowell[9]

[1]*Korea Polar Research Institute (KOPRI)*
[2]*University of Science and Technology (UST)*
[3]*NASA, GSFC, Greenbelt, MD, USA*
[4]*Yonsei University*
[5]*Korea Astronomy and Space Science Institute (KASI)*
[6]*National Observatory of Athens, IAASARS, Penteli, Greece*
[7]*MIT, Haystack Observatory, MA, USA*
[8]*George Mason University, Fairfax, Virginia, USA*
[9]*NOAA SWPC, Boulder, Co, USA*

We expand our previous assessment of modeling capabilities in predicting the ionospheric climatology in terms of foF2 and hmF2 during moderate/high solar activity (Tsagouri et al. 2018). In this study, we evaluate new simulations from upgraded models (the International Reference Ionosphere (IRI) model version 2020, Massachusetts Institute of Technology (MIT) Empirical models of NmF2 and the Coupled Thermosphere Ionosphere Plasmasphere Electrodynamics (CTIPe) model version 4.1) and from the NCAR Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension (WACCM-X) version 2.2 including 3 simulations in the previous study. A simulation from the NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model version 2 (TIE-GCM 2.0) is also included for comparison with WACCM-X. Monthly medians of foF2 and hmF2 are considered to evaluate the model performance for the entire year of 2012. For quantitative evaluation, we employ skill scores, including the coefficient of determination (R2), root-mean square error, mean error, and mean relative error. Although significant errors are occasionally obtained from all modeling approaches, empirical models tend to provide systematically better correlation with the observed medians and follow the observed distributions more successfully, offering smaller prediction errors than the physics-based ones. The physic-based models show hemispheric differences in performance in predicting foF2 and hmF2, while the empirical models perform similarly for both the northern and southern hemispheres. Seasonal and local time dependences of the models' performance differ among the models and characteristics.

13:45 [IV-1-2]

Optimizing Deep Learning Models for Ionospheric TEC Prediction: Insights from Storm-to-Quiet Day Ratios

Se-Heon Jeong[1], Woo Kyoung Lee[1,2], Jeong-Heon Kim[1], Soojeong Jang[3], Hyosub Kil[4], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology (UST)*
[3]*Kyung Hee University*
[4]*Applied Physics Laboratory, Johns Hopkins University*

The ionospheric Total Electron Content (TEC) is a critical parameter for the accuracy of satellite communication and navigation systems. Geomagnetic storms, primarily driven by solar activities, introduce significant variability in the ionosphere, posing substantial challenges to TEC prediction. Conventional models often fail to capture the complex dynamics introduced by these irregular events, leading to inaccuracies in TEC forecasting. In this study, we are conducting experiments to explore how the deep learning model's predictive accuracy is influenced by variations in the ratio of storm to quiet days within our training dataset. This experiment enables us to evaluate the model's performance across diverse ionospheric conditions. Our preliminary results suggest that maintaining a balanced representation of storm and quiet days in the dataset could be crucial for the model's capability to forecast TEC during geomagnetic disturbances. Our deep learning approach employs the Convolutional Long Short-Term Memory (ConvLSTM) network, an innovative framework designed to capture spatial-temporal relationship for TEC map prediction (Jeong et al. 2024). As part of our dataset, we utilize TEC maps reconstructed from the Deep Convolutional Generative Adversarial Network - Poisson Blending (DCGAN-PB) model (Jeong et al. 2022). This model effectively preserves small-scale ionospheric structures observed in TEC data.

14:00 [IV-1-3]

Cross-Comparison of IGS TEC Using Jason TEC at the Continent-Ocean Boundary

Woong Jeon[1], Eun-Young Ji[2], Yong-Jae Moon[1,2], Young-Sil Kwak[3]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*
[3]*Korea Astronomy and Space Science Institute*

In this study, we have made a cross-comparison of IGS

(International GNSS Service) TEC using Jason TEC from 2002 to 2021 at the continent-ocean boundary. Although IGS TEC has the advantage of global coverage, its accuracy is low in oceanic areas due to the shortage of observing stations. In contrast, Jason TEC represents directly observed data in oceanic areas. IGS TEC is 71 × 73 grid-type data with resolutions of 2.5 degrees in latitude, 5 degrees in longitude, and 2 hours in time. We use Jason TEC data with 1-min time cadence at the continent-ocean boundary for which both IGS and Jason TEC data are available. We make linear regressions between Jason TEC and IGS TEC for annual TEC data. Main results from this study are as follows. First, they have high correlation coefficient (CC) which range from 0.91 to 0.97, with an average of 0.94 and a standard deviation of 0.02. Second, the CC values are lowest in 2009 and 2018 (near solar minimum) and highest in 2003 and 2011 (near solar maximum). Third, the linear regression is expressed by IGS = (1.06 ± 0.06) × Jason + (3.80 ± 1.24). Such high and consistent CC values suggest that the cross-comparison of IGS TEC should be made using Jason one. We hope that this study would be used for improving the accuracy of IGS TEC in oceanic areas.

14:15 [IV-1-4]

Comparative Analysis of Space Environment Data Extracted with GOLD Satellite Image Noise

Jonglil Lee[1], Jaeheung Park[2], Dae-Young Lee[1]

[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*

GOLD (Global-scale Observations of the Limb and Disk) satellite instrument is not specifically designed for observing radiation belts or particle flux, since its geostationary orbit placement in October 2018, it has been providing observation images of the ionosphere-thermosphere. Previous studies, using SOHO (Solar and Heliospheric Observatory) image cases, have demonstrated the possibility of inferring high-energy particle flux. Utilizing observed image noise through machine learning algorithms or AI techniques to infer electron flux could extend the application to commercial purposes. Images acquired by various satellites launched for commercial purposes (e.g., weather images) could also be input into similar relational expressions to produce space science data. If the images from several operating commercial satellites can be utilized, it would be possible to obtain energy observations in locations not covered by existing science satellites (e.g., the United States' GOES, Korea's KSEM), such as over Africa. This represents a new method of utilizing previously underutilized image data and could significantly contribute to maximizing the utility of satellite data.

14:30 [IV-1-5]

Retrieval of Total Electron Content according to Vessel Movement in the Northwestern Pacific

Dong-Hyo Sohn[1], Byung-Kyu Choi[1], Junseok Hong[1], Yosup Park[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Institute of Ocean Science and Technology*

The Global Navigation Satellite System (GNSS) is an effective tool to estimate the signal delay caused by total electron content (TEC) in the ionosphere. GNSS-derived TEC is widely used to characterize the variability of the ionosphere. Unfortunately, however, most GNSS stations are installed on land. In contrast, GNSS observations made in the ocean are relatively insufficient. GNSS data collected from moving vessels could palliate this lack of coverage. In this study, we estimate TEC using GNSS measurements from the research vessel traveling between the mid- and low-latitude regions of the Northwestern Pacific. To study the GNSS TEC variation in the mid-to-low latitude, the campaign was conducted for about one month using a weighing 5,894 tons research vessel 'ISABU' operated by the Korea Institute of Ocean Science and Technology. We derived the ship's position and GNSS TEC, and performed a comparison between the ship-borne GNSS-derived TEC and global ionosphere map TEC.

제2발표장 Convention B

IV-2 우주산업

Chair: 한우제(KTL)

13:30 [IV-2-1]

Introduction to the Development Status of Green Propellant-Based Propulsion System for Domestic Orbital Transfer Vehicle Development

Daeban Seo, Hyunjun Kim, Seongmin Joo, Su-Jin Choi, Kuem-Oh Lee, Keejoo Lee, Jaesung Park

Korea Aerospace Research Institute

Recently, services for transporting small satellites into space orbit using OTV (Orbital Transfer Vehicle) equipped with propulsion system are being provided by several companies in the launch service market. This services not only provides various launch options for small satellites, but also generates high profits for service providers. Most OTVs use propulsion systems based on green propellant to reduce development and operation costs. Korea Aerospace Research Institute (KARI) is also considering the development of OTV to improve the usability of domestic launch vehicles, and is conducting a basic

technology research on green propellant-based propulsion system.
In this paper, we briefly introduce a development trend of OTVs and the development status of green propellant-based propulsion system for domestic OTV development.

13:45 [IV-2-2]
Development of Device Level Space Components for Satellite Application

Young-Jun Cho

Korea Aerospace Research Institute

Many satellite units are being developed domestically, but device-level space components are still entirely dependent on imports. Therefore, the risks related to the device level in satellite development are increasing. In response to this, the development of space devices was carried out together with domestic device manufacturers. In this paper, we introduce the current status of space devices developed domestically. A total of 9 device types were selected for development. Six types of passive devices have been developed and three types of active devices is in progress.

14:00 [IV-2-3]
Enabling Platform Development for In-Space Pharmaceutical Manufacturing

Hyeonjun Kim[1], Jun-uk Shim[2], Hargsoon Yoon[2], Daeban Seo[1], Sungmin Joo[1], Keejoo Lee[1], Jaesung Park[1]

[1]*Korea Aerospace Research Institute*
[2]*Space Liintech*

It is needed to pay attention to a system to return to Earth after completing a mission as Nuri launch vehicle is successfully developed. A government support still play a pivotal role in domestic space development though private space companies are leading the space development because private investment in space companies still be small in scale. A government want to foster an ecosystem for the space industry, but this is only achievable when an ample amount of demands is either guaranteed by public needs or generated by new commercial businesses in space. Varda space industries have recently achieved a historic milestone on Feb. 21, 2024, after its W-1 (Winnebago-1) capsule successfully landed at the Utah with products it made in microgravity. It means that it could revolutionize pharmaceutical production and supply chains through In-space pharmaceutical manufacturing technology. In this study, the possibility of developing Varda-like system for In-space pharmaceutical manufacturing is described.

14:15 [IV-2-4]
Orbit Determination Accuracy Analysis of GEOKOMPSAT-3 Based on Ground Ranging

Bong-Kyu Park, Jun Hyoung Yoll, Park Keun Joo

Korea Aerospace Research Institute

GEOKOMPSAT-3(GK3) is a geostationary satellite that utilizes electric propulsion and GNSS receivers for autonomous station-keeping. This technology is the first of its kind in Korea. In case of GNSS failure, ground-based ranging information will be used to determine the orbit. The position and velocity information of the satellite will be generated every 30 minutes and uploaded to the satellite. The satellite will then interpolate the uploaded data to obtain the orbit information at any desired time.
This paper analyzes the expected orbit determination accuracy when using two ground ranging stations in the event of a GNSS receiver failure. The GEOKOMPSAT-2 (GK2) satellite currently performs this orbit determination, showing an accuracy of within 500 meters, satisfying the 2 km requirement. However, separate analysis is necessary for GK3 due to its different disturbance environment from electric propulsion thruster firing.

제3발표장 Convention C

IV-3 SS: L4 관측기기 III

Chair: 김록순(천문연)

13:30 [IV-3-1]
Overview of Science Goals and Requirements with *In Situ* Observations at the Sun-Earth Lagrangian Point L4

Dae-Young Lee[1], Rok-Soon Kim[2], Kyung-Eun Choi[3], Jungjoon Seough[2], Junga Hwang[2], Dooyoung Choi[1], Ji-Hyeon Yoo[1], Seunguk Lee[1], Sung Jun Noh[4], Jongho Seon[5], Kyung-Suk Cho[2], Kwangsun Ryu[6], Khan-Hyuk Kim[5], Jong-Dae Sohn[2], Jae-Young Kwak[2], Peter H. Yoon[7]

[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Space Sciences Laboratory, UC-Berkeley, USA*
[4]*Los Alamos National Laboratory, USA*
[5]*Kyung-Hee University*
[6]*Satellite Technology Research Center, KAIST*
[7]*University of Maryland, USA*

The Korean heliospheric community, led by the Korea Astronomy and Space Science Institute (KASI), is currently assessing the

viability of deploying a spacecraft at the Sun-Earth Lagrange Point L4 in collaboration with National Aeronautics and Space Administration (NASA). The aim of this mission is to utilize a combination of remote sensing and in situ instruments for comprehensive observations, complementing the capabilities of the L1 and L5 observatories. This presentation outlines long term scientific objectives and requirements, underscoring the significance of multi-point *in-situ* observations to better understand critical heliospheric phenomena. These include coronal mass ejections, magnetic flux ropes, heliospheric current sheets, kinetic waves and instabilities, suprathermal electrons and solar energetic particle events, as well as remote detection of solar radiation phenomena. Furthermore, the mission's significance in advancing space weather prediction and space radiation exposure assessment models through the integration of L4 observations is discussed. We conclude the talk with an emphasis on the potential of L4 observations to propel advancements in heliospheric science.

13:45 [IV-3-2]

Basic Properties of *In Situ* Measurements of Solar Wind Plasma and Outline of Scientific Questions for L4 Mission

Jungjoon Seough[1], Kyung-Suk Cho[1,2], Roksoon Kim[1], Yukinage Miyashita[1,2], Jong-Dae Sohn[1,2], Junga Hwang[1,2], Jeong-Yeol Han[1,2], Dae-young Lee[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Chungbuk National University*

The Korean heliophysics community is currently carrying out a feasibility study for the Sun-Earth Lagrangian 4 point mission. For a better understanding of global and small-scale structures and physical properties of solar wind plasma, the L4 mission shall be designed to equip a variety of in situ payloads including the fluxgate and search coil magnetometers, electric field and radio/wave detector, as well as two kinds of particle detectors measuring solar wind plasmas and high-energy particles, respectively. The present talk aims to introduce the basic properties of solar wind plasma in connection with in situ measurements, and to outline the scientific questions that could be addressed by the L4 mission.

14:00 [IV-3-3]

Solar Wind Plasma Analyzer for the Korean L4 Mission: Lessons Learned from the STSAT-1/ESA

Jaeheung Park[1], Jae-Jin Lee[1], Jongdae Sohn[1], Kyoung Wook Min[2], Jungjoon Seough[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Physics, KAIST*

Instruments measuring low-energy (10 eV–10 keV) electrons and ions are an essential part of solar science missions. The Korean space science community has just begun a conceptual design of its own L4 mission, which will definitely carry solar wind particle detectors. Before we get into a detailed design phase, it is warranted to know about the heritage and current status of Korean technology in developing such low-energy particle instruments. In this presentation, we briefly review the design, calibration, and data usage of the Electro-Static Analyzer (ESA) onboard STSAT-1, which successfully probed near-Earth low-energy electrons from 2003 to 2005. Based on this heritage, we discuss possible future steps for developing solar wind detectors that will be carried by the Korean L4 mission.

14:15 [IV-3-4]

Conceptual Study of a High-Energy Particle Detector in the Heliosphere Assuming an L4 Mission

Woo-Hyeong Seol[1], Jongho Seon[1], Khan-Hyuk Kim[1], Kwangsun Ryu[2], Jungjoon Seough[3], Jongdae Sohn[3], Junga Hwang[3], Kyung-Suk Cho[3], Dae-young Lee[4]

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[2]*Korea Advanced Institute of Science and Technology, Satellite Technology Research Center*
[3]*Korea Astronomy and Space Science Institute*
[4]*Chungbuk National University*

Observations at the Sun-Earth Lagrange Points are expected to become crucial satellite missions, ultimately enhancing the understanding of the solar environment by significantly expanding observations from a spatial perspective. Among these missions, observations from the L4 position, which leads Earth in its orbit around the Sun, are anticipated to offer complementary data to missions such as the United States SwFO mission planned for launch in late 2020 for the L1 point, and the European VIGIL mission for the L5 point, thereby making the scientific significance highly diverse and profound. In this paper, we aim to conduct a conceptual study of a high-energy particle detectors capable of measuring solar energetic particles in the energy range of approximately 30 keV to 30 MeV, which can be operated from the L4 position. We have analyzed the specifications and scientific objectives of high-energy particle detector payloads planned for missions such as L1 and L5, as well as those previously operated in solar environment missions. Additionally, we plan to deliberate on the types and ranges of observational physical quantities that need to be selected to maximize scientific outcomes when operating similar payloads for future L4 missions.

14:30 [IV-3-5]

Conceptual Study of Radiation Monitor for

Investigating Space Radiation Environment and Biological Effects at L4 Lagrange Point

Jongdae Sohn[1], Ukwon Nam[1], Jungjoon Seough[1], Junga Hwang[1], Kyung-Suk Cho[1], Jongho Seon[2], Kwangsun Ryu[3], Dae-young Lee[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*School of Space Research, Kyung Hee University*
[3]*Satellite Technology Research Center, KAIST*
[4]*Chungbuk National University*

This paper focuses on a conceptual study of a Radiation Monitor for investigating the radiation environment and biological effects at the L4 Lagrange Point. L4 represents one of the Lagrange points where objects tend to stably gather in space, situated between the Earth and the Sun, forming an equilateral triangle with them. As seen from the Sun, the L4 points lie at 60 degrees ahead of and behind Earth, close to its orbit. In the Medium to long-term, the strategic value of L4 is very great because it has the feature of being able to view the entire space (cislunar) between the Earth and the Moon, even though the distance from the Earth is relatively long. In addition, this L4 Lagrange point is a good space observatory for constant observation of the sun and solar wind and is also the best and optimal location for studying the space radiation environment and biological effects. If an observation mission is conducted at this point, its scientific significance is expected to be very great. In this paper, we will briefly present the scientific goals and payload specifications of a radiation measuring instrument that can study the radiation environment and biological effects at the L4 Lagrange point.

제4발표장 Vega Hall

IV-4 안보우주 III

Chair: 최호성(육군)

13:30 [IV-4-1]

Deep Learning-Based Ground Vehicle Detection Using Satellite SAR Images

Ji-Hoon Park, Ji Hee Yoo, Inho Seo, Kyeung Keun Kim

Agency of Defense Development

There have been a number of researches on object detection from synthetic aperture radar (SAR) imagery thanks to the advent of deep learning algorithms. In contrast to other researches that deal with open dataset of SAR ship targets, this paper presents deep learning-based detection and instance segmentation results using our dataset of SAR ground vehicle targets acquired from commercial satellite SAR images. We also analyze the experiment result with the metrics of detection performance, such as mean average precision. Finally, the future research directions are suggested to facilitate other researches aiming to improve the performance of deep learning-based detection.

13:45 [IV-4-2]

SpaceSCANeR: Development of Surveillance and Reconnaissance Cube Satellites

Tae-Yong Yang[1], Jaejin Lee[1], Daehee Lee[1], Goo-Hwan Shin[2], Soojong Pak[3], Geon Hee Kim[4], SpaceSCANeR Team[5]

[1]*Korea Astronomy and Space Science Institute*
[2]*Satellite Technology Research Center, KAIST*
[3]*Kyung Hee University*
[4]*Department of Defense and Space Engineering, Hanbat University*
[5]*SpaceSCANeR Team*

With the advent of the New Space era, the role and importance of cube satellites are growing day by day. Korea Astronomy and Space Science Institute's SpaceSCANeR mission aims to perform a complementary mission in conjunction with the existing high-resolution surveillance and reconnaissance satellite system in line with the increased utility of cube satellites. By developing, launching, and operating four or more cube satellites in formation, we aim to detect and track unknown targets that exist in a wide area on the ground. In this presentation, we would like to introduce the system design review of SpaceSCANeR, a surveillance and reconnaissance cube satellite development mission.

14:00 [IV-4-3]

Experimental Demonstration of a Newly Designed Optical Communications Terminal (OCT) at a Distance of 20 km

Wonseok Kang[1], Taewoo Kim[1], Sang Hoon Oh[1], Yong-Sun Park[1,2], Jung-Hoon Kim[1,3]

[1]*Spacebeam, Inc.*
[2]*Seoul National University*
[3]*SETsystem, Inc.*

Optical laser communications in space offer remarkable downlink speeds by using a highly focused laser beam. The NASA TeraByte Infrared Delivery (TBIRD) mission has demonstrated successful data transmission of 4.8 terabytes in a pass through a narrow beam of approximately 380 μrad. Additionally the TBIRD team has announced to achieve the

Pointing Acquisition Tracking (PAT) with a beam divergence of 100 μrad, utilizing a 25-cm diameter ground terminal.
In preparation for space experimentation, we present a ground-based demonstration of a newly designed optical communications terminal (OCT) at a distance of 20 km. Initially, the beam divergence of the OCT was estimated through mapping received powers while shifting the beam. Subsequently, the beam from the OCT was successfully received by the 25-cm diameter ground terminal at the specified distance. Our experiment validates the feasibility of ultra high definition (UHD) live streaming using our OCT over a 20 km range.
Furthermore, we carried out a comparative analysis between the experimentally obtained receiving power and the calculated receiving power derived from a link budget analysis, which incorporates considerations for beam divergence. Base on this analysis, we propose potential solutions for space-to-ground optical laser communications at distances exceeding 1,000 km.

14:15 [IV-4-4]
CubeSat and CubeSat Constellation for Military

Jae-Pil Park, Geuk-Nam Kim, Jinyoung Shin, Seongwhan Lee, Jung-Kyu Lee, Kwangwon Lee

Nara Space Technology

It is getting more important for real-time observation by satellite constellation for modern warfare. CubeSat is an optimized satellite for mass manufacturing. So it can build satellite constellation fast. CubeSat constellation fills in the time gap of existing low earth orbit satellites for the military. This paper introduces a 25 kg satellite, 'Observer' which is a standard CubeSat of Nara Space Technology. It also contains the mission result of 'Observer' and constellation plan for military surveillance.

14:50~16:20 포스터 발표

제4발표장 Vega Hall

정책포럼 II

Chair: 김주현(항우연)

16:20 [정책포럼 II-1]
Policy Suggestions for Establishing the National Space Exploration Roadmap

Hyoung Joon An

Science and Technology Policy Institute

According to the Fourth Basic Plan for the Promotion of Space Development announced in 2022, South Korea is planning to explore the moon in 2032 and Mars in 2045. However, the plan only declares the main targets of space exploration, but lacks concrete action plans or a step-by-step strategy. In preparation for the government's upcoming space exploration roadmap in 2024, this study presents policy proposals to identify a shortlist of challenging and high-impact science missions and a strategy for their implementation.

16:20 [정책포럼 II-2]
Strategic Vision for KASA: Setting Scientific Goals and Supporting Concept Studies

Minsun Kim

Korea Astronomy and Space Science Institute

In this presentation, we explore how the KASA can benefit from policies grounded in scientific goals and objectives for space exploration and development, alongside support for concept studies. Key to the KASA's success, establishing a science mission directorate and setting scientific goals (Big Questions) provide clear direction, enhancing focus on research and development, fostering international cooperation, and inspiring future professionals in STEM fields. NASA exemplifies this approach by allocating a significant portion of its budget (~30% of the total budget, refer to NASA FY2024) to its Science Mission Directorate, aiming to tackle big scientific questions/challenges. NASA's missions are informed by scientific communities through decadal surveys, guiding its space exploration and development initiatives.
Support for concept studies is equally important for KASA's future, encouraging innovative and groundbreaking ideas/projects by assessing their feasibility early on. This support is vital for addressing the big questions of space exploration and development, which demand long-term investment and research. By facilitating contributions from diverse entities like universities, institutions, startups, and individual researchers, this policy enriches the ecosystem of space exploration, fostering innovation and competitiveness. For example, through the NASA Innovative Advanced Concepts (NIAC) program, NASA supports 10 to 20 such pioneering projects annually, expecting that these visionary ideas could eventually transform future NASA missions, thereby demonstrating the policy's impact on advancing space science and technology.

16:20 [정책포럼 II-3]
Recent Activities of ISECG and Its Implication

Dong Young Rew, Soyoung Chung, Yee-Jin Cheon, Ami Yoon

Korea Aerospace Research Institute

The International Space Exploration Coordination Group (ISECG), which is a forum of space agencies to advance the global exploration strategy, is preparing an updated global space exploration roadmap based on NASA's Moon to Mars architecture and the recent activities and plans of other space exploration nations. An update of the critical technologies for the roadmap is also being prepared based on technology gap assessments and analysis of existing critical technologies required. This paper introduces the recent discussions in the ISECG and examines the implications from the Korean perspective.

16:20 [정책포럼 II-4]

International Legal Review of National Plans for Space Resource Mining and Its Implications for Commercial Space Exploration Strategies

Ryun Young Kwon

Korea Astronomy and Space Science Institute

The April 2020 executive order by President Donald Trump of the United States, titled "Encourage International Support for the Recovery and Use of Space Resources," sparked significant international controversy regarding the commercial utilization of space resources. In particular, the Artemis Accord initiated by the United States in October 2020 with the participation of eight countries clearly demonstrated that these actions were not merely declaratory but accompanied by concrete plans. Consequently, domestic and forign media defined this as a new space resource competition, leading countries such as Japan and Luxembourg to promptly establish domestic laws on space resource development and utilization. In the "4th Plan for Promotion of Space Development", the South Korea government also mentions resource mining as a new industry field and plans to establish domestic laws concerning space resource utilization. Furthermore, the South Korean government announced the Future Space Economy Roadmap in November 2022, declaring the lunar landing and resource mining commencement in 2032. We aim to examine the relevance of the policies announced by the United States and find the meaning of commercial space exploration and private ownership rights over space resources. The policies include the Commercial Space Launch Competitiveness Act (2015), National Security Strategy (2017), National Space Strategy (2018), Space Policy Directive-2 (2018), Executive Order (2020), and Artemis Accord (2020). Lastly, this paper establishes a strategic framework for South Korea's national plan to pursue space resource mining, utilization, and commercial space exploration.

4월 26일(금) 제1발표장 Convention A

V-1 SS: 태양광회절 추진 우주항해

Chair: 전현진(항우연)

10:40 [V-1-1]

Trends and Implications of Space Exploration Missions Using Solar Propulsion

Hyun-Su Lim, Dong-Young Rew, Sang-Seob Park

Korea Aerospace and Research Institute

The advanced space development countries, such as the United States and Europe, have been pursuing research and development on deep space exploration using solar propulsion. Since solar propulsion can provide continuous thrust to the spaceship without additional fuel, solar propulsion navigation technology said to be an essential technology for space exploration. In the case of reflection-type solar propulsion, there are cases where some advanced space countries have launched probes for technology verification, and only basic research on diffraction-type solar propulsion technology has been conducted worldwide. The solar diffraction propulsion method has the advantage of being able to use the force generated laterally even when facing the sun, making it easier to control the attitude compared to the reflection method, and reducing the development and launch costs of the probe through weight reduction.
In this paper, we present domestic and international development trends in space exploration missions using solar propulsion technology, such as polar region observation of the sun, solar storm monitoring and interstellar exploration missions, and discuss technical risks in major development cases and use cases in Earth's orbit.

10:55 [V-1-2]

Transverse Efficiency for Diffractive Solar Sailing, and Comparison with Reflective Sailing

Hyeon-Jin Jeon

Korea Aerospace Research Institute

Technical studies on the solar sailing, featured with continuous acceleration and inexhaustible energy source, have been continuously conducting since 1920s, and its first solar sailcraft, IKAROS was launched by JAXA at 2010.
Most of studies so far for solar sailing have been focusing on the reflective sailing which obtains the transversal force by off-pointing the sail from the sunlight direction. As a result of that, there is a solar radiation pressure loss in accordance with the off-pointing angle, and it is difficult to install solar panels on the solar sail because of its off-pointing angle.

In order to improve the shortcomings from the reflective sail, the alternative study on the diffractive solar sailing is recently emerged, which can obtain the transversal force with sun-facing attitude.
This paper derives a mathematical form of the transverse efficiency for the diffrative solar sail and compares its transverse acceleration with that of reflective sail. This paper can be a good guideline to design a diffractive solar sailcraft.

11:10 [V-1-3]
Consideration of Satellite Electrical System Requirements for Diffractive Solar Sailing

Sangman Moon, Changkyoon Kim, Inkyu Kim,
Korea Aerospace Research Institute

In this paper, in order to consider the requirements for the design of the satellite electrical system of a diffractive solar sailing, we will discuss the electrical requirements for the attitude control system and deployment system for the solar sail device of the diffractive solar sailing system similar to the solar sailing based on reflection. Deployment system for the solar sail device is included camera or sensor payload system for the monitoring of the solar sail deploy step by step. The case of the power production when before and after sail deploying for the diffractive solar sailing system was deduced by taking the example of the attitude control system of the existing solar sailing based on reflection system. This paper hopes to be helpful in the initial design of satellite electrical systems for the diffractive solar sailing of the deep space exploration and navigation.

11:25 [V-1-4]
A Survey on the Solar Sail Communication Frequency Spectrum Band

In-Kyu Kim, Sang-Man Moon, Chang-Kyoon Kim, Yee-Jin Cheon
Korea Aerospace Research Institute (KARI)

After the first solar sail to make use of space craft propulsion using the solar radiation was IKAROS launched in 2010, Scientists and Engineers around the world encourage and continue to work on solar sail technology to investigate the possibility of using solar sails as means of transporting humans. The solar sail has developed the subsystems with the cube satellite parts as well as communication systems. In this paper, we present the spectrum utilization status of communication system in solar sails. Solar sails are constructed using cube components. In particular, the solar sail communication utilizes CubeSat communication modules, Therefore, the solar sail frequency spectrum is same as the CubeSats's frequency band. We shows the international spectrum allocation, management, and planning of the frequency band for CubeSat communication, based on the ITU-R report.

11:40 [V-1-5]
Mechanical Characteristics of Space Solar Sail Spacecrafts

Min-Ki Kim, Seung-Yong Min, Beom-Suk Kang
Korea Aerospace Research Institute

Space solar sail is light and continuous propulsion system for deep space exploration. Solar sail has been categrized into two kinds of propulsion, the one is solar reflective type and the other is diffractive one. Some reflective solar sail spacecrafts has been launched such as IKAROS, NanoSail, LightSail, and NEA Scout. Solar sail enables permanent propulsion, but they have many uncertainties and design difficulties due to wide flexible thin membrane, compared to conventional propulsion system. In this paper, mechanical characteristics and deployment mechanisms of solar sail spacecraft which has been already launched.

제2발표장 Convention B

V-2 SS: 학부생 세션

Chair: 정종균(천문연)

10:40 [V-2-1]
Establishment of Requirements and Initial Calculation for ECliPSE's Three Reaction Wheels for Attitude Control

Chae Yoon Kim[1], Heesu Yang[2], Hojin Lee[2], Du Won Ki[1], Jeon Min Hyeok[1], Gybum Kim[1], Ji Eun Choi[3]
[1]*Korea Aerospace University*
[2]*Korea Astronomy and Space Science Institute, UST*
[3]*Chungnam National University*

ECliPSE is a project developing a prototype balloon gondola capable of reaching an altitude of 30 km with a focus on solar observations. We have designed a reaction wheel mechanism (RWM) for the attitude control of the 30 kg gondola mass. The mechanism consists of three reaction wheels arranged in a pyramid shape to efficiently compensate the torque generated by the pendulum motions of the gondola. In this presentation, we will discuss parametric studies of the RWM, initial mechanical design, and tolerance calculations. We plan to make a prototype of the gondola equipped with the RWM and

conduct ground experiments in the upcoming summer.

10:55 [V-2-2]

Analyzing Satellite Aurora Observations for CAS500-3/ROKITS Image Applications

Se Rin Jeon[1], Woo Kyoung Lee[2,3]

[1]*Department of Geological Sciences, Chungnam University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

This study examines auroral observations from satellites to develop the Republic of Korea Imaging Test System (ROKITS) data processing system and scientific products. ROKITS, a wide-field auroral and airglow imager onboard the Compact Advanced Satellite 500-3, is set to launch in late 2025. The primary aim of ROKITS is to identify the auroral oval and its various shapes in visible wavelengths. To achieve this, we analyze auroral observations using optical imagers, specifically e-POP/Fast Auroral Imager (FAI), and FUV imagers, DMSP/Special Sensor Ultraviolet Spectrographic Imagers (SSUSI). Leveraging e-POP/FAI optical observations, we establish criteria for auroral identification in images. These criteria enable us to statically calculate auroral boundaries and compare the results obtained from 630.0 nm and near-infrared observations. Furthermore, we investigate the occurrence characteristics of auroras across different wavelengths by analyzing e-POP/FAI and DMSP/SSUSI observations. Through the examination of coincident observations, we explore auroral structures in both near-infrared and FUV wavelengths, allowing us to discern fine-scale details in optical images within low-resolution DMSP/SSUSI FUV images.

11:10 [V-2-3]

Near-Infrared Imaging-Spectroscopic Observations of the Moon: Drift Scanning Method Reveals 1μm Absorption Line Features at Reiner Gamma

Minwook Kang[1], Namhun Kim[1], Jayeon Lee[1], Yangha Ju[1], Heesu Yang[2]

[1]*Department of Astronomy & Space science, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

This study collects lunar observation data using Drift Scanning method, we succeeded in assembling a comprehensive data set of the full moon from December 5 to December 6, 2023. Calibration was completed using ASTM G173 standard data, which facilitated the investigation of the spectrum within the observed lunar data from 9,000 to 11,000 nm. This allowed us to elucidate the spectral differences in the vicinity of Rayna Gamma. While differences in albedo due to the moon's geological characteristics, sensor sensitivity, and image processing nuances challenge the scientific reliability of the data, the educational value is clear. We presented a comparative analysis of absorption line differences near Rayna Gamma, where generally, the existence of an absorption line at approximately 1 μm was verified.

11:25 [V-2-4]

Design of Jupiter's CH^4 Spectroscopic Observation System and Analysis of Its Spectral Data

Seungye Lee[1], Seungmo Hong[1], Heesu Yang[2]

[1]*Department of Astronomy and Space Science, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

Jupiter is a gas giant planet primarily composed of hydrogen and helium. But trace amounts of components such as methane and water also exist. These components can be identified by observing the spectrum. We designed and manufactured a small spectrograph targeted the Jupiter's CH_4 bands. The resolving power of the spectrograph is 1,000, which is sufficient for observing CH_4 bands. To obtain imaging-spectroscopic data of the Jupiter, we mounted the small spectrograph on a 10-inch reflecting telescope, and observations were conducted using a drift-scanning method. We identified methane lines located at 620 nm, 700 nm, and 725 nm. By comparing 2D images filtered at these methane lines, our data may show variations in the strength of methane lines in the Jupiter's belts compared to other regions. We will discuss these results in our presentation.

11:40 [V-2-5]

Imaging-Spectroscopic Observations of the Sun Using the Drift-Scanning Technique

Jeonghyoen Lee[1], Jiyoon Jeon[1], Uijin Gu[1], Hana Kim[1], Daewon Kim[1], Heesu Yang[2]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute, KASI*

In solar observation, As each spectral line reveals distinct characteristics of the corresponding atmospheric layer, it is necessary to observe the Sun in various wavelength bands to understand the solar phenomena comprehensively. In this study, we designed and fabricated a spectrograph with a 2400-groove diffraction grating and achromatic lenses. Employing this spectrograph, we obtained solar imaging spectral data of Hα, Hβ, and Ca II H&K using the drift scanning technique. Our observations showed the sunspots in the continuum images, solar filaments in the Hα images. Ca II H&K images also show prominent filigrees at the surface. In this talk, we present the fabrication process, observation, data processing, and the

observation results.

11:55 [V-2-6]

Pre-Processing of the Imaging Spectroscopic Data

Hana Kim[1], Heesu Yang[2], Junghyun Lee[1], Uijin Gu[1], Jiyoon Jeon[1], Daewon Kim[1]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

The raw spectrum obtained using the ECHALLAN-a small normal spectrograph with a single slit- and the Makstov 90 mm telescope requires correction for dark current, flat field, slit pattern, and aberrations. We have developed a data processing routine for the correction. Our processing algorithm effectively removes the slit pattern and spectrum distortion. But because the gain of the CMOS sensor changes unexpectedly when we took the data with a high framerate, some data is contaminated by this issue. In this presentation, we will introduce our data processing algorithm in detail.

제3발표장 Convention C

V-3 SS: L4 관측기기 IV

Chair: 이대영(충북대)

10:40 [V-3-1]

Conceptual Design of a Fluxgate Magnetometer for L-4 Mission

Seunguk Lee[1], Kwangsun Ryu[1], Dooyoung Choi[2], Jimin Hong[1], Su-Hwan Park[1], Enno B. Starossek[3], Jae-Young Kwak[4,5], Yukinaga Miyashita[4,5], Jungjoon Seough[4], Jaeheung Park[4,5], Junga Hwang[4,5], Jong-Dae Sohn[4], Kyung-Suk Cho[4,5], Dae-Young Lee[2]

[1]*Satellite Technology Research Center, KAIST*
[2]*Chungbuk National University*
[3]*Department of Aerospace Engineering, KAIST*
[4]*Korea Astronomy and Space Science Institute*
[5]*University of Science and Technology*

From the perspective of space sciences, magnetometers are essential instruments that allow us to understand the magnetic field structure and behavior of plasma in space. The Fluxgate magnetometer is an instrument that measures quasi-DC magnetic fields. This allows us to measure very slow changes in magnetic fields as well as waves in the sub-ultra-low frequency band, which correspond to tens of Hz. The fourth Lagrangian point (L-4) of the Earth-Sun system is a meta-stable point located 1 AU from the Sun and 60° ahead of the Earth's orbit. This point is important for predicting solar activity and analyzing the origin of space science phenomena. The magnetic field environment at this location is very different from that of the Earth, with a very small magnitude and the instrument encounter an extreme temperature environment. Therefore, designing a magnetometer for the L-4 location involves many considerations. This study presents the performance requirements and considerations for the fluxgate magnetometer for the L-4 mission.

10:55 [V-3-2]

The Primarily Study of Search Coil Magnetometer for Space Research

Ho Jin, Kwan-Hyuk Kim

School of Space Reseach, Kyung Hee University

The Search-Coil Magnetometer is a magnetic field wave instrument used in space research. Its primary purpose is to measure the magnetic field in space environments, providing valuable insights into the dynamics of the magnetosphere and its interactions with solar wind. This tool's high sensitivity allows for the detection of even the minutest magnetic fluctuations, significantly contributing to space weather forecasting and research. For these scientific objectives, we are developing a three-axis space-based Search-Coil magnetometer with ASIC devices. This payload instrument can be utilized not only for planetary sciences but also for measuring solar magnetic field activity. The frequency range of this magnetometer spans from 10 Hz to 20 kHz, and its noise equivalent magnetic induction (NEMI) is 10 $pT/Hz^{1/2}$. Due to the large observation data set, we are also studying an AI decision routine in the on-board computer. We anticipate that this routine will reduce the data volume while delivering essential information. In this presentation, we introduce the test results of the lab model search coil magnetometer and discuss future work.

11:10 [V-3-3]

Conceptual Design of Electric Field and Radio/Wave Detector for L-4 Mission

Kwangsun Ryu[1], Seungwook Lee[1], Jimin Hong[1], Su-Hwan Park[1], Enno B. Starossek[2], Jaeyoung Kwak[3,4], Yukinaga Miyashita[3,4], Jungjun Seough[3], Jongdae Sohn[3], Junga Hwang[3,4], Jaeheung Park[3,4], Kyungsuk Cho[3,4], Jongho Seon[5], Khan-Hyuk Kim[5], Kyung Chan Kim[6], Dae-Young Lee[6]

[1]*Satellite Technology Research Center, KAIST*
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[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*
[5]*School of Space Research, Kyung Hee University*
[6]*Chungbuk National University*

Observations from the Lagrange points are anticipated to significantly enhance our physical understanding of the heliosphere, as they enable extended monitoring of the Sun and solar wind without the need for additional propulsion fuels. Among various payloads for operation at the L-4 location, this research focuses on a conceptual study of electric field and radio/wave observation devices. We analyze the instruments' scientific and operational objectives, along with their specifications. The primary goal of the E-field and Radio/Wave detector is to capture radio burst signals from near the Sun and local plasma waves within Earth's 1 AU orbit. We delve into the detection mechanisms and electronic schemes for capturing these plasma waves across the specified spectrum. Additionally, we assess the current Technical Readiness Levels (TRLs) of related technologies and propose strategies to sufficiently advance these TRLs for the L-4 mission.

11:25 [V-3-4]
Preliminary Study of Deployable Boom Structures for an L-4 Mission

Enno B. Starossek[1], Jae-Hung Han[1,2], Kwangsun Ryu[2], Seunguk Lee[2], Kyung-Suk Cho[3,4], Yukinaga Miyashita[3,4]

[1]*Department of Aerospace Engineering, KAIST*
[2]*Satellite Technology Research Center, KAIST*
[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*

An L-4 mission would improve our understanding of the sun and the heliosphere through the measurements it would enable. Such a mission requires multiple dipole antennas and magnetometers. For both instruments, deployable boom structures are necessary. These are structures that are able to increase their length once required. For the antennas, the structural body of the boom is the antenna itself. For magnetometers, usually one magnetometer is located at the end of the boom, while another one is located in the middle to measure the influence of the spacecraft on the measurements.
This study reviews the different boom types and evaluates and compares them in their performance for an L4-mission.
Next, the types that are suitable are selected and described in more detail. As the requirements for the antenna boom and the magnetometer boom are different, the booms are different for both applications. Aspects that have to be considered during structural design are presented. The requirements of such a mission for the booms are introduced and it is discussed how they could be fulfilled. Then, the problems that could occur to the booms during the mission are considered. After that, it is reviewed how the booms could be manufactured.

11:40 [V-3-5]
Dust Detector and Science

Thiem Hoang[1,2], Kyungsuk Cho[1], L4 team

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea University of Science and Technology*

Interplanetary dust particles (IDP) and interstellar dust (ISD) are fundamental components of the solar system, holding clues to its origin and evolution. ISD also offers a unique opportunity to study the properties of the interstellar medium in-situ. In this talk, we will explore the current understanding of IDP and ISD, highlighting key unanswered questions like physical properties, and chemical composition. We will then discuss the advantages of a L4 mission to detect dust and revolutionize dust science. By characterizing the physical properties, chemical composition, and dynamics of these particles, the L4 mission can significantly improve our understanding of the formation and history of our solar system and the composition of the interstellar medium. Finally, the talk will explore potential detector options for the L4 mission.

제4발표장 Vega Hall

V-4 우주감시

Chair: 최 진(천문연)

10:40 [V-4-1]
Analysis of the Orbit Maneuvers of North Korea's MALLIGYONG-1 Satellite Using Space Surveillance Radar Tracking

Eun-Jung Choi

Korea Astronomy and Space Science Institute

On 21 Nov. 2023, North Korea's first military reconnaissance satellite, Malligyong-1, was launched aboard a new type of Chollima-1 rocket from the Yunsong satellite launch center. It is in a sun-synchronous orbit at an altitude of about 500km. In cooperation with LeoLabs, the Korea Astronomy and Space Science Institute monitored the Malligyong-1 using the Leolabs' space surveillance radar. In this paper, we present the results of the orbit analysis based on the available information from CSpOC and the Leolabs' radar observation. It was analysed that Malligyong-1 performed a total of 7 orbit maneuvers from 19 to 24 Feb. The orbit maneuvers were analysed to maitain a sun-synchronous orbit and increase the perigee altitude from

488 km to 497 km.

10:55 [V-4-2]

Observational Strategies for Optimal Operation of NSOS-α

Hee-Jae Lee, Myung-Jin Kim, Youngmin JeongAhn, Hong-Kyu Moon, Dong-Goo Roh, Hong-Suh Yim, Jaemann Kyeong, Jung Hyun Jo, Jang-Hyun Park, Sungki Cho

Korea Astronomy and Space Science Institute

The Near Space Optical Survey-alpha (NSOS-α) telescope is South Korea's first dedicated asteroid surveillance telescope. It is scheduled for installation in Chile with a target completion date in early 2027. The telescope features a diameter of approximately 1.5 m and a field of view of 2.24° × 2.24°. The purpose of this telescope is to proactively detect near-Earth and potentially hazardous asteroids, preparing us for potential threats. To ensure the successful operation of NSOS-α, it is imperative to devise and implement optimized observation strategies geared towards detecting asteroids posing potential threats to Earth in advance. Therefore, we aim to investigate the celestial distribution of near-Earth asteroids using Granvik's near-Earth asteroid population model, with the goal of understanding the orbital characteristics of undiscovered near-Earth asteroids. Additionally, based on this analysis, we intend to devise optimal observation strategies for detecting these asteroids and share the results.

11:10 [V-4-3]

NSOS-Beta (Near Space Optical Survey-Beta): Objectives and Operation

Jin Choi, Jung Hyun Jo, Hong-Suh Yim, Dong-Goo Roh, Myung-Jin Kim, Jang-Hyun Park, Jaemann Kyeong, Sungki Cho, Eun-Jung Choi, Jiwoong Yu, Seong-Yeol Yu, YeonGil Jung, Wookyung Lee, Hong-Kyu Moon

Korea Astronomy and Space Science Institute

A dedicated infrastructure, known as NSOS-beta (Near Space Optical Survey-beta), is planned for development to detect, identify, track, and monitor space objects in orbits above 2000 kilometers. The primary aim of this system is to monitor Korean MEO/GEO (Medium Earth Orbit / Geostationary Earth Orbit) space objects to reduce collision risks with other objects such as space debris. The primary targets include not only GEO satellites but also KPS (Korean Positioning System) Inclined-GEO satellites. To achieve this objective, NSOS-beta will operate in survey and targeting modes. This presentation will outline the main objectives and operational concepts.

11:25 [V-4-4]

The Construction of ADS-B Receiving System for Aircraft Surveillance Detection in Sejong SLR System

Ki-Pyoung Sung, Man-Soo Choi

Korea Astronomy and Space Science Institute

The SLR (satellite laser ranging) system is a system that precisely measures the distance from the ground to the space object by emitting a laser from the ground. Space object surveillance using an SLR system can cause accidents such as temporary or permanent vision loss and flash blindness of aircraft pilots due to lasers emitted from the ground.
Currently, the Sejong SLR system has been designed to use an ASRS (aircraft surveillance radar system) to detect aircraft in the direction of a laser in real-time and stop the laser. However, we need to maintain high cost and professional workers for mainance of ASRS. AS one the alternative to solving this problem, the ADS-B (automatic dependent surveillance-broadcast) system is being built and tested. This paper address the ADS-B receiving system in Sejong SLR system.

포스터발표 논문 초록

발표시간 : 4월 25일(목)
14:50~16:20

[P-1] A Flexible 1553B Interface Design for Sharing the BUS of Multiple External Unit

Seung-Eun Yang

Korea Aerospace Research Institute

MIL-STD-1553B is widely used communication standard for aerospace field. It is a time division multiplexing serial bus. Therefore, multiple external unit can be connected to the bus. Each external unit only share the same bus, but the command & telemetry protocol can be different depend on the application. To deal with the various protocol, a flexible 1553B interface design is proposed. RT Rx message is defined as direct command and indirect command. Direct command required only data words but in-direct command is required pointer and data word. The direct command is appropriate for simple command as mode management and the indirect command is suitable for memory or parameter update. RT Tx message is defined as periodic telemetry, aperiodic telemetry and dump data. Each type of message can be applied to required application. With the various interface methods, multiple external unit can be easily connected the same bus.

[P-2] Comparison and Evaluation of Air-Cooled Dry Pump Performance for Thermal Vacuum Chambers

Sung-Wook Park[1], Sun-ki Baek[2], Keun-sik Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*Hanyang ENG*

When performing the thermal vacuum test essential for satellite development, a dry pump is used to form a low vacuum. Conventional dry pumps often adopt the water-cooled type because of their high heat generation. However, due to the recent technological advances, many air-cooled pumps are also being released. In this paper, the possibility of introducing an air-cooled pump was examined by comparing the performance of the water-cooled and air-cooled pump.

[P-3] VxWorks Downloadable Application Build for Flight Software Development

Su-Hyun Park

Korea Aerospace Research Institute

Flight software is embedded on the spacecraft computer and executed to control the spacecraft. Korea Aerospace Research Institute (KARI) has been developing the spacecraft flight software with a commercial real-time operating system, VxWorks. Latest versions of VxWorks provide the development tools (compiler, linker and etc.) with graphical user interface and with the command line interface, as well. KARI has been using the old version of VxWorks for the flight software development and the version we have does not provide the command line interfaces officially. In this paper, we introduce the build script written to automate the build process using TCL scripts provided by VxWorks. The flight software is built in two steps. First step is to build a VxWorks downloadable application image which will be loaded to the random access memory (RAM) of the target computer. For the future work, we are working on the build script for VxWorks bootable system image which will reside in Non-Volitile Memory permanently.

[P-4] Measuring Astronomical Seeing at Jang Bogo Station

Chung-Uk Lee[1], Hyuck-Jin Kwon[2], Dong-Joo Lee[1], Jong-Kyun Chung[1], Changsup Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Polar Research Institute*

The Fried parameter is a physical quantity that indicates how stable the atmosphere is above an observatory. Typically, it is around 5 cm, with optimal locations ranging from 10–30 cm. The most important requirements for ideal sites for optical astronomy observations are a low-humid transparent stable atmosphere and darkness. The inner land of Antarctica is known to fulfill these conditions, and the polar nights lasting about 3 months provide a space-like dark observation environment. Preliminary research on the optical observation environment for the future inner land of Antarctica has been conducted. In this study, we present results measured at the Jang Bogo Station using an optical observation system set up on-site temporarily.

[P-5] A Study on Ways to Improve the Technical Document Registration Process for Configuration Management Baseline Management

Chul Kang

Korea Aerospace Research Institute+

Satellite development requires configuration management work performed throughout the entire development cycle.
The main elements of configuration management work consist of configuration identification, configuration control, configuration status management, and configuration verification tasks.
Among these, configuration control work is performed through configuration baseline management. The configuration baseline

is a standard for performing configuration change management of configuration control.
It is a set of identifiers at a defined point in time, allowing standards to be redefined due to design change activities during the product life cycle.
The status of the baseline must always be maintained. Currently, the baseline management of the satellite development project is in operation.
Although it is managed based on the registration information of technical documents in the technical data management system, due to the time difference between the issuance and registration of the actual technical documents,
There is difficulty in maintaining the status quo. Accordingly, we describe the existing baseline management and maintain the status quo.
We aim to present an efficient baseline management plan by improving the technical document registration process of the technical data management system.

[P-6] A Study on the Utilization of GLORIAD Network for Advanced Multi-Satellite Operation

Hyun-Chul Baek, Tae-Gun Son, Jae-Hyoung Park
Korea Aerospace Research Institute

The National Satellite Operation and Application Center has operated many overseas ground stations to secure the stable operation of multiple satellites and to receive satellite intelligence. Since establishing a dedicated circuit for this purpose costs tremendous expenses, it is recommended to establish a safe network by utilizing security equipment, such as a VPN, on the level of L3 or L7 rather than a dedicated circuit. Since most global research networks (GLODIAD) are connected to KREONET, it is possible to transmit satellite data quickly and securely by utilizing this network. When a network is formed in this way, KARISNET involves contact points with external networks, and in terms of security, it is vital to separate and manage such network contact points. For contact points with external Internet networks, there need to be physical, managerial, and technical security measures by configuring the security equipment in line with the general security guidelines of the institution, such as DMZ, Firewall, IDS, DDoS defense system, NAC, and so forth.
Notably, circuits interlinked with KREONET IP networks and dedicated circuits of KARISNET are recommended to be separately established. Otherwise, the following methods should be applied: First, two optical cores are separated. Second, two circuits are configured using optical equipment to secure separation. Third, two EPLs are created through the MPLS, or at least 2 VLANs are created for separation. Even though the traffic processing performance of the security equipment has advanced, security policies are increasing accordingly. Therefore, degradation of the network performance in security areas is inevitable. The Science DMZ Architecture is widely utilized among GLORIAD networks to overcome this challenge. The most fundamental concept is that the traffic flowing through security areas of the border route before the firewall into specific internal sites is distinguished from the traffic taking a roundabout way and flowing into a kind of DMZ area. To detour security areas, the system is designed to communicate only with IPs in the white list according to security policies. This study presents methods to configure KARISNET for multi-satellite operation, receive satellite videos by interlinking overseas ground stations based on the GLORIAD, enhance transmission speed, and improve security.

[P-7] Ground Communication Loss Check

Dong-Seok Chae
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In a satellite, the command processing function from the ground is one of the most important functions. If it cannot receive and process ground commands, the satellite is almost useless. The satellite checks whether ground commands are received and processed normally. If there are no commands from the ground for 72 hours, it is considered a communication loss and the corresponding procedure is performed. However, currently only the error is recorded and no other procedures have been established. If there is a problem with the command processing function, it cannot be recovered with ground commands, so it must be performed automatically without ground commands. A function is required to monitor whether there are any problems at each step of command processing and to change the relevant configuration to a part that does not have any problems. This paper briefly describes the function of receiving and processing commands and describes how to detect communication loss and automatically change the configuration appropriately.

[P-8] The Launch Vehicle Mechanical Interface Check and Separation Shock Test of Large Optical Satellite Flight Model

Kilyong Hwang[1], Chihyun Cho[2], Kyungwon Kim[1], Heekwang Eun[1], Gyusun Kim[1]
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[2]*Korea Aerospace Industries*

Generally, mechanical verification of separation between satellite and launch vehicle is accomplished through separation shock tests. Through the separation shock test, the mechanical interface between the satellite and the launch vehicle can be checked, and the level of shock delivered to the satellite can be measured.
This large optical satellite has an interface that combined with the launch vehicle and the 1194 CASA clamp-band. We

installed shock sensors at five locations on the satellite's marmon ring to measure the separation shock well. The harness between the satellite and the launch vehicle is connected by an umbilical connector, and the interface details between the brackets that secure it were indirectly checked in a static state. We confirmed that the separation impact level met the requirements and checked that there was no physical interference with the clamp band, etc. during the separation.

[P-9] Study of the Dedicated Test Equipment for In-Plane Shock Excitation

Jong-Hyub Jun, Hee-Kwang Eun, Nam-Jin Moon, Jin Park, Chang-Rae Cho, Tae Seok Oh

Korea Aerospace Research Institute

A satellite gets exposed to the shock environments inevitably during launching and orbit-working. They are caused mainly by launch vehicle separation or appendages deployments like solar array and payload in the satellite. In the process to develop a satellite, many verification steps should be accomplished for the shock tests. KARI has the dedicated shock test machine for the satellite's parts using pneumatic actuators and resonator to generate the characteristic frequency (1,000 or 1,500 Hz). This machine needs L-shaped fixture for the in-plane shock excitation. However, the fixture is heavier than the flat-shaped fixture for out-of plane excitation, leading to low capacity to generate shock energy. Therefore, the in-plane shock was a little limited to meet the requirement in KARI.
In this study, the existing shock equipments in the world are reviewed, and the flat shaped shock interface is analyzed fundamentally by numerical simulation to design a new dedicated in-plane shock test equipment with the better performance.

[P-10] Analysis of Star Imaging Window for the Image Calibration of Optical Earth Observation Satellite in Low Earth Orbit

Jeong Hoon Hyun

Korea Aerospace Research Institute

Electro-optical satellites in Low Earth orbit which have been operated by Korea Aerospace Research Institute take images of specific star clusters to calibrate the focus of their payloads. Since there exist constraints such as a small number of suitable clusters, the visibility of star tracker which are one of satellite's attitude sensors, and battery power, the imaging window is often narrow and sometimes vanished. In this paper, I briefly introduce a basic strategy of star imaging planning and analyze the imaging window in terms of imaging time/point, target cluster, and attitude profile.

[P-11] Early Operation Scenario Analysis for Initial Signal Acquisition and Communication of Low Earth Orbit Satellite

Kyunsang Park

Korea Aerospace Research Institute

For the stable operation in the early operation phase of low earth orbit satellite, it is important to maintain the satellite's attitude pointing to the sun. In the aspect of the satellite's attitude control, after the separation from the launch vehicle, the solar panel deployment is inevitable, because the sun pointing attitude is determined by the coarse sun sensor in the solar panel. Moreover, before the initial communication with the ground station, the limited equipments are just used to save the energy consumption from the battery. In the first contact with the ground station, we have to investigate whether the solar panel is deployed or not as soon as possible. Thus, in this paper, the criteria for the solar penal deployment are suggested and the energy budget is also analyzed from the launch to the first communication with the ground station.

[P-12] Statistical Analysis of Mission Planning for Geostationary Satellites

Hye-Won Kim, Sang Cherl Lee

Korea Aerospace Research Institute

Korea Aerospace Research Institute (KARI) is operating three geostationary satellites in current. Among these satellites, Geo-Kompsat-2A/2B (GK-2A/2B) were launched on 5 December 2018 and 19 February 2020, respectively. They have different Earth observational missions, which are the meteorological mission for GK-2A and ocean/environmental mission for GK-2B. Advanced Meteorological Imager (AMI), which is boarded on GK-2A, can be monitored the atmospheric condition over the Korean peninsula. Also, this payload has availability to observe the severe weather such as typhoon over not only Korean peninsula, but observable area within the specification of payload, and it called 'special mission'. On the other hand, two payloads have simultaneously been operating in GK-2B, Geostationary Environment Monitoring Spectrometer (GEMS) and Geostationary Ocean Color Imager-2 (GOCI-2). In order to avoid mission conflicts for GK-2B, mission planning of GEMS and GOCI-2 is following the time and systematic constraints that were configured at the early stage of development. In this study, a quantitative analysis of the Earth observation payload, which are AMI, GEMS, and GOCI-2, will be discussed in terms of the operational results.

[P-13] Development of Space-Class Custom Magnetic

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EEE parts applied in satellites rely on imports from overseas. Space-grade electronic components not only need to be designed considering the space environment but also require complex manufacturing processes to enhance the reliability of the components. Consequently, domestic production of these components is minimal. In line with the localization of space components, technological development focusing on material selection, manufacturing processes, and verification is underway to ensure high reliability for domestically produced electronic components for space applications. While German ASP (Advanced Space Power Equipment GmbH) products are currently used for space-grade magnetic components, efforts are being made domestically to research and develop high-reliability space-grade components for diversifying the supply chain. Korea Testing Laboratory, in collaboration with Sensorpia Inc. and MID Inc., is conducting research on the development of custom space-grade magnetics. Through this development, efforts are directed towards securing technology related to space-grade magnetic component materials, processes, and verification techniques, with a significant emphasis on high-reliability quality assurance to enable the application of various magnetic product categories.
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[P-14] Considerations for the Design of Power supply for the Signal Processor of Focal Point Unit of Low Earth Orbit Satellite

Young-Yun Kim, Young-Sun Kim, Jong-Pil Gong, Haeng-Pal Heo

Korea Aerospace Research Institute

Selection of the detector, stable and robust power and driving clock supply circuit of the detector, circuit design for signal processing of analog signals obtained from the detector, and circuit design for stable transmission of digital signals should be optimized in order to obtain a high-quality image for a low-orbit satellite mounting using a CCD image sensor from an electronic point of view. In particular, signal processing including ADC performed at the stage after the detector greatly affects signal quality. Stable signal processing operation is the basis for minimizing signal noise. For minimized noise operation of ADC, many factors need to be taken into account. We examined the factors to take into account while building the power supply for optimal signal processing operation in this study.

[P-15] Analysis of TDI MTF Degradation due to the Optical Distortion of Electro-Optical Camera

Jeoung-Heum Yeon, Eung-Shik Lee

Korea Aerospace Research Institute

As the resolution of the electro-optical camera inscreas, the number of photons and corresponding electrons collected on a single pixel decreases. Therefore, the SNR (Signal to Noise Ratio) performance is difficult to achieve for pushbroom scanning camera of high resolution. To overcome this obstacle, TDI (Time-Delayed Integration) thchnique is generally used. TDI pixels are composed of multiple linear arrays and electrons generated by the exposure of the one line are transferred and collected to the next lnes. Therefore, the number of collected electrons increased and SNR increased consequently. TDI pixel direction has to be coincide with the scanning direction to prevent mis-match effect. However, optical distortion can lead to the mis-match effect even for the best alligned scanning direction. In this study the relationships between optical distortion and TDI mis-match effects are analyzed. The optical bluring effects and MTF impacts are analyzed according to the TDI step and the magnitude of optical distortion. The results can be utilized for the estimation of TDI MTF and overall camera MTF budgeting.

[P-16] Study for Improving Transients and Surges due to Initial Power Supply to Satellites

SuWan Bang, Yungoo Huh

Korea Aerospace Research Institute

In general, when developing a satellite, Power input following the initial power connection of the satellite is not greatly considered. However, surges and transient phenomena that may occur during initial operation may cause significant damage to the satellite’s internal circuit.
First, the paper covers the types of transient phenomena and surges that can generally occur, and then deals with the response methods that have been previously discussed according to each transient phenomenon and surge type. It also covers damage to internal semiconductor components due to these transient phenomena and surges. In addition, existing solutions to these transient phenomenon and surge problems are largely divided into digital and analog methods. In addition, the paper presents a mixed method of digital and analog methods and presents the simulation results of the method. Through this method, it is possible to respond to transient phenomena and surge problems with the initial voltage during future satellite development.
Accordingly, this paper deals with the types of transient phenomena and surges and measures to prevent them during the initial operation of the satellite.

[P-17] GEO-KOMPSAT-3 MGSE Test Specifications and Planning

Hyung Wan Kim, Jung Su Choi, Jong Seok Park

Korea Aerospace Research Institute

Mechanical Ground Support Equipment (MGSE) is critical for the assembly, integration, and testing of spacecrafts. However, defining precise test specifications and planning for MGSE tests remain challenging, impacting the efficiency and safety of space missions. This paper addresses the gap by proposing a comprehensive framework for GEO-KOMPSAT-3 MGSE test specification and planning. Through a detailed analysis of existing MGSE testing methodologies and leveraging case studies from recent space missions, we identify key factors influencing MGSE test effectiveness. Our approach combines theoretical models with practical considerations, resulting in adaptable test specifications and a dynamic test planning guide. Findings indicate that systematic test planning, coupled with flexible specifications, significantly enhances MGSE testing outcomes. The study underscores the importance of integrating mission-specific requirements with industry best practices to optimize MGSE testing. Implications for future research and practical applications in MGSE test planning are discussed, offering a roadmap for advancing the field.

[P-18] Field of View Analysis of Geo-Kompsat-3 Satellite

Jung Su Choi, Jong Seok Park, Hyung Wan Kim

Korea Aerospace Research Institute

The GEO-KOMPSAT-3 development program is a national initiative aimed at developing a geostationary communication satellite for public use by the Korean government. The GEO-KOMPSAT-3 is a mission satellite equipped with Flexible Broad Band Communication (FBCS), Satellite Based Augmentation System (SBAS), and Data Collection System (DCS). To optimize performance, it is crucial that the Field of View (FoV) from the satellite attitude and orbit control sensors is not obstructed along the sensors' specific directions and angle of view. The design of the spacecraft should take into account not only sensors but also antennas, and spacecraft shadow. This study involves the generation of 3D FoV CAD models for the GEO-KOMPSAT-3 satellite sensor units to verify the completion of the requirement. Furthermore, based on the 3D CAD data, considerations are made for potential FoV interferences from the solar array shadow, attitude orbit control sensors, and data communication antennas to prevent degradation of spacecraft performance.

[P-19] Propellant Consumption Estimation by an Electric Propulsion System for a Geostationary Telecommunication Satellite

Jong Seok Park, Jung Su Choi, Keun Joo Park, Hyoung Yoll Jun

GEO-KOMPSAT-3 Program Office, KARI

The GEO-KOMPSAT-3 satellite will be equipped with HEMPT based electric thrusters to meet the extended mission lifetime and accommodate the increase payload mass compared with the previous GEO-KOMPSAT platform based satellites. This electric thruster, which is used for north/south station-keeping maneuver, will inevitably undergo some performance degradation with time during its lifetime, therefore it is required to perform the propellant budget analysis to reflect this degradation when determining the propellant loading capacity.
In this paper, it is estimated the propellant consumption by the electric thrusters on the GK3 satellite to reflect their performance degradation in thrust and specific impulse and it is presented the compatibility of the propellant consumption with the current tank capacity.

[P-20] Geostationary Earth Orbit Satellite Solar Array Wing Deployment Operation Design

Keun Joo Park

Korea Aerospace Research Institute

A GEO communication satellite for multiple communication mission is being developed by Korea Aerospace Research Institute. To provide the required power for communication payloads and electric propulsion subsystem the satellite will be equipped with two solar array wings. Generally, several constraints such as thermal and electrical constraints need to be considered in the operation design.
In this paper the solar array deployment operation which cover both transfer orbit and mission orbit is presented.

[P-21] Modal Analysis of Geo-Stationary Satellite Structure for Case Study of Mass Distribution

Hyun-Jin Shin, Ji-Hwan Seo

Korea Aerospace Research Institute

Geo-stationary satellite is widely used for variety applications, such as navigation, telecommunication and weather forecasting, etc. Generally, Geo-stationary structure developed by KARI has the central-tube structure. Central-tube structure configuration has the advantage of providing the good load path for propulsion parts, such as main tanks and propellant which is one of the heaviest thing in the satellite. And bus and payload components on the structure panels interfaced to central tube through shear webs.
This study was introduce the result of modal analysis for one

mass distribution case in order to assess the geo-stationary satellite structure with central-tube configuration.

[P-22] Research on Redundant Design Methods for Stable Mission Operation of the High Reliability Satellite Systems and Components

Jong-Euk Park, Haeng-Pal Heo

Korea Aerospace Research Institute

Satellite systems designed for various purposes are capable of performing optimal missions depending on their purpose and operating orbit.
It is designed to consist of several parts, components and boxes. Due to the unique characteristics of satellite operation, a failure may result in a fatal loss of mission performance.
To ensure stable operation of the major components that go into the satellite, a primary and redundant concept design is used. Among the redundancy methods used in satellite design, the method of manufacturing additional parts with the same function depends on the design budget (cost, size, weight, etc.) of the satellite system. Because it has a significant impact, it places a burden on the configuration of satellite systems that require limited design margin. Other than these methods, there is a method that does not significantly affect the design of the satellite system, without manufacturing a separate box. A method of implementing redundancy through path change through switches and relays can be considered.
By changing the two paths within a single part, you have the option to operate under a variety of conditions.
In this paper, we study a redundancy implementation method using the switches and relays that can be mainly used in satellite systems. These design methods and various operation methods were described.

[P-23] Manufacturng and Tests of CFRP (Carbon Fiber Reinforced Plastic) Facesheets Sandwich Panel for Geo-Stationary Satellite

Chang Ho Kim[1], Jihwan Seo[1], Jongmin Park[2], Jeongha Jeon[2]

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Satellite structure should be designed to accommodate and support safely the payload and equipments necessary for its own missions and to secure satellite and payloads from severe launch environments. The environmental loads such as quasi-static acceleration, sinusoidal vibration, acoustic loads and shock loads are imposed on satellite during launch. Satellite structure is typically designed with sandwich panel in order to secure sufficient mounting area and to achieve enough stiffness with effective mass as low as possible. The facesheets of sandwich panel usually adopt aluminum due to easy manufacturing, good performance and low cost. But as aluminum can expand and shrink under space thermal environment, aluminum facesheets can affect the thermal pointing of optical payloads and antenna payloads. For the mission where thermal pointing of payloads is important, CFRP(Carbon Fiber Reinforced Plastic), which is stable for thermal environment, is applied to facesheets instead of aluminum. As CFRP is orthotropic material, the facesheets made of CFRP laminate have various mechanical properties depending on the lay-up of laminate, manufacturing process, etc. Due to severe thermal pointing requirement of Geo-stationary satellite, CFRP facesheet is going to be applied. This paper deals with the manufacturing of CFRP facesheets sandwich panel for process verification and coupon tests for acquisition of mechanical properties.

[P-24] Review on the Battery Charging Anomaly at Constant-Voltage Control Mode of Paralleled Solar Array Regulator

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Typically, a solar array regulator used for LEO satellite applications has three operational mode for power generation control from solar panel; power limiting mode, maximum power point tracking (MPPT) mode and constant voltage (CV) regulation mode. In addition, it is also common to implement one solar array regulator module requiring large power capability with several lower power handling converters. The number of solar array regulator module is mostly decided by the configuration of solar panels. The power limiting mode is required to mitigate the peak generated power at the entrance of sun-period and the maximum power conversion capability of the solar array regulator because if the converter is designed in consideration of the peak power in the initial daytime phase, it will be too excessive. In this paper, review on the battery charging operation anomaly at the CV operation mode of paralled solar array regulator is summarized and presented.

[P-25] PCB Layer Design Change for LVDS Output Signal Enhancement

Jong-Tae Lee, Eung Shik Lee, Haeng-Pal Heo

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LVDS (low voltage differential signaling) is often used on high speed data communication line due to low power consumption and external noise resistant characteristics. But it can be vulnerable to noise sources by using low voltage. While developing space-born electronic device, LVDS signal was corrupted by coupling two primary and redundant FPGA output

signals. Initially it was assumed that the two FPGAs are electrically separated, but update to the data sheet revealed that this was not the case. Adjusting resistance and capacitance of outside of the FPGA was not enough to solve this problem. To minimize reflections and cross-talk between signal lines and to improve signal grounding, PCB layer design was changed. Hopefully this design change will be a reference materials for the developing similar LVDS communication error.

[P-26] Contamination Control in Space Systems

Su-Young Lee

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There are nine categories of satellite failures. Impact of collision induced failure, battery failure, solar mechanical failure, attitude control failure, failure due to plasma-discharge events, cell failure, other array failure, darkening of glass or solar reflectors, and cell interconnect failure. Since contamination affects satellites, it is crucial to control contamination in space systems to avoid satellite failures. In my laboratory, we detect organic contamination by using a molecular witness plate for molecular contamination and PFO (particle fall-out) for particulate contamination. The goal is to develop effective ways to control contamination. In this paper, I will present the current status of the development of methods to control contamination in space systems.

[P-27] Analysis of North-South Station Keeping Error due to Plume Disturbance in the Geostationary Satellite

Wooyong Kang

Korea Aerospace Research Institute

The station keeping box in geostationary satellites is a designated area that ensures the satellite remains within specified longitude and eccentricity (or inclination) ranges. Its purpose is to prevent collisions with other satellites and minimize radio frequency interference while maintaining stable operation. Geostationary satellites experience perturbations due to Earth's gravitational field, solar and lunar forces, which cause an increase in eccentricity and inclination. To counteract this, periodic orbit adjustments are performed using thrusters. However, using thrusters can lead to disturbance known as thruster plume disturbance. In the case of GEO-Kompsat (Geostationary – Korea Multi-Pulpose Satellite), there is interference between the thrusters and solar pannel during the north-south station keeping. Therefore, when generating commands for north south station keeping, this interference must be considered. In this study, we analyzed the impact of thruster plume distrubance during north south station keeping. Simulation results revealed that the magnitude and direction of the perturbations vary based on solar array angles, resulting in orbit errors of 2 kilometers.

[P-28] Power Safe Attitude Adjustment for Orbit Change Operation

Seonho Lee

Korea Aerospace Research Institute

Orbit maintenance is important in LEO satellite operation since the mission performance is optimized at the designed orbit. For the interferometry application, the radar satellites are required to adjust their orbit regularly, e.g., several times per week to overcome the orbit perturbation such as the air drag, the gravity gradient, the solar pressure, and etc. This paper proposes a power safe attitude adjustment method for orbit adjustment operation of LEO satellites. The method reads the command quaternion for delta-v and the Sun vector that are defined in ECI frame as an inputs for the main algorithm. In return, the algorithm generates the modified attitude quaternion that makes the satellite's solar array look at the Sun as much as possible for the sake of power generation during delta-v operation. The proposed algorithm was verified for various delta-v operation scenarios and will be implemented at the mission control system of KOMPSAT ground station.

[P-29] A Study on GK3 FDIR (Failure Detection Isolation Recovery) Critical Design Progress Status

Chang-kwon Cho, Bongkyu Park, Jong Seok Park, Keunjoo Park

Korea Aerospace Research Institute

GK3 Satellite is currently under detailed design. The FDIR of GK3 is also in the detailed design along with the overall system development progress. The Preliminary design of the FDIR defined the FMECA for each subsystem unit, the FDIR mode transition diagram, and the satellite operation phases. Based on these, FDIR of the system and subsystem are being designed. The detailed design of the processes for each level is being performed based on the FDIR architecture defined in the early stage of FDIR development. In addition, a Limited Normal Mission Mode, which was not present in the previous GK2 satellite, has been defined and designed. The Limited Normal Mission Mode is a mode that can increase the availability of the communication satellite by allowing the mission to continue even if some units fail. The design of this mode is the core of the FDIR design for GK3 satellite.
This paper analyzes and summarizes the concepts of the detailed design based on the FDIR architecture, focusing on the level-by-level design.

[P-30] Simulation of Ghost Phenomenon for

Space Electro-Optical Camera

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The electro-optical cameras mounted on satellites are used for space missions such as Earth observation, astronomical studies, and lunar exploration. Consequently, a high level of camera resolution performance is required to meet the demands. However, various optical factors can lead to a degradation in image quality, with ghost image caused by multiple reflections in the optical system being a prominent factor.
In this study, we introduce the ghost testing of the space-grade electro-optical camera we conducted, along with its images. We reproduced this phenomenon using the ray-tracing program ASAP to identify its causes. By simulating this ghost phenomenon, we were able to examine the causes, images, and optical paths of ghosts that may occur in actual orbits.

[P-31] KPLO Ground System Payload Science Data Receiving Module Development and Operation Status

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Korea Aerospace Research Institute (KARI) has developed South Korea's very first lunar exploration program, Korea Pathfinder Lunar Orbiter (KPLO) and launched it in Aug 5, 2022 and KPLO has been successfully inserted on the mission orbit since Jan. 1, 2023. KARI has also developed the KPLO Deep-space Ground System to operation KPLO and one of KDGS's function is Payload science data Receiving Module (PRM). KPLO has five science instruments including Lunar Terrain Imager (LUTI), KPLO Magneto-meter (KMAG), Wide-Angle Polarimetric Camera (PolCam), KPLO Gamma Ray Spectrometer (KGRS), and ShadowCam (SHC). PRM has a capability to ingest X- band receiving raw data files, generate science telemetry files (TM file), and deliver them to each Science Operation Centers (SOCs). PRM has a monitoring function of science data processing status and a separate function to generate TM files manually. Each science instrument do have a slightly different space packet format and PRM can handle these different features. This paper is presenting PRM's major functions and operation status in KPLO Mission OPeration Cener (KMOC).

[P-32] Performance Drift Results of CMOS Image-Sensor on Electro-Optical Payload before and after Proton Exposure Test

Ilseop Lee, Jong Pil Kong, Sang-Gyu Lee

Korea Aerospace Research Institute

Electronic equipment, such as image-sensors onboard satellites, should be immune to cosmic radiation to perform normal missions in space. The image-sensor mounted on electro-optical payload is a newly developed or redesigned electronic components suited to the mission, and radiation hardening design is required, and cosmic radiation exposure tests on the developed image-sensor are also required. Cosmic radiation exposure tests for electronic devices include TID (Total Ionizing Dose) testing uisng gamma-ray, DD (Displacement Damage) testing using protons, and SEE (Single Event Effect) testing using heavy ions. These radiation exposure tests can help predict image-sensor performance degradation at EOL (End Of Life). In this paper, the performance measurement results of CMOS Image-sensor before and after proton irradiation are described.

[P-33] Extended Mission Orbit Design for the Korea Pathfinder Lunar Orbiter (KPLO): Case Studies of Low Lunar and Frozen Orbits to Maximize Scientific Return

Young-Joo Song, Jun Bang, Jonghee Bae, SeungBum Hong

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO) has been successfully orbiting the Moon since its insertion into mission orbit (at an altitude of 100 km ± 30 km and with a 90-degree inclination) in January 2023. The Korea Aerospace Research Institute (KARI) is now preparing for KPLO's extended mission, focusing on maximizing scientific outcomes based on payload needs. This work presents case study results of the KPLO extended mission orbits. Initially, five extended orbit options were derived from assessments of preferable orbit options from KPLO payloads. Two representative case scenarios were then selected by considering various bus and ground operational constraints. Detailed orbital characteristics for both cases are discussed, along with delta-V budgets. The first case includes KPLO flying in Low Lunar Orbit (LLO) with an altitude of 60 km ± 30 km before a flight above the target location prior to surface impact. The second case involves KPLO flying in LLO, then inserting into a frozen orbit (60 by 200 km) before transitioning to a highly elliptical orbit prior to surface impact. The KPLO flight dynamics team will continue to work closely with the payloads team to refine the current candidate orbit options for KPLO's extended mission.

[P-34] The Individual PID Controller of Focus Ring Heaters for Satellite Electro-Optical Camera

Ki-Hoon Seo, Youngsun Kim, Hyung-Yun Noh, Haeng-Pal Heo

Korea Aerospace Research Institute

The heating control of focus ring for the fine focus adjustment can be used for the satellite electro-optical camera due to its reliability. Fine focus control is achieved by controlling the temperature difference between the upper and lower rings. Radial temperature control within the ring is also used together to prevent the tilted focus. The PID controller is generally used for temperature control because of its simplicity, ease of implementation and accuracy. This paper introduces the individual PID controller for both temperature difference control between the upper and lower rings and radial temperature control within the ring. The individual PID controller consists of two PID controllers, one for the temperature difference and the other for the radial temperature. To achieve desired temperatures for camera focus, these two PID controllers control each heater individually and work together in a time-sharing fashion. Simulation results show that desired temperatures are well achieved by the individual PID controller.

[P-35] Heat Source Design of Radioisotope for Spacecraft

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The primary power source for most spacecraft and satellites is solar panels. In mission environments such as Earth orbit, interplanetary and space operations where there is sufficient sunlight, they can perform stable missions by generating power through solar panels and charging batteries. However, in conditions where solar energy cannot be obtained due to being far from the sun or other limitations, alternative power sources must be utilized. Currently, for such spacecraft, the use of the decay heat of radioisotope is possible. Radioisotope thermal generator (RTG), which produce power using the heat from radioisotope, and Radioisotope heater unit (RHU), which utilize the heat directly from the heat source, are among them. RHUs, in particular, operate differently from conventional heaters designed to operate within a certain range, as they emit continuous heat from radioactive isotope. This characteristic differs from the typical approach to thermal design. Similar to electronic boxes emitting heat, nuclear heaters could maintain temperatures above a minimum allowable limit under low-temperature conditions. Additionally, under high-temperature conditions, radiators are necessary to maintain temperatures within the maximum allowable range, given the continuous heat emission of RHUs. However, , if low-temperature conditions are reconsidered based on the designed radiator, the previously determined power of the RHU may be insufficient. This implies that the need for the design that simultaneously considers the power of the RHU and the size of the radiator. Our study focused on analyzing temperatures in a simplified model of spacecraft with RHUs based on RHU's power variations. The results could serve as a reference for thermal design using RHUs in an insufficient solar flux environment on spacecraft.

[P-36] Analyzing Geolocation Precision of Danuri Using LUTI of Apollo Program Landing Site

Jonghee Bae, Jo Ryeong Yim

Korea Aerospace Research Institute

The lunar orbiter, Danuri, successfully entered lunar orbit by the end of December 2022, performing on its lunar scientific mission ever since. Operating within an orbit altitude of 100+/−20 km and an inclination of 90 degrees. Danuri is equipped with six payloads, facilitating the acquisition and transmission of various lunar scientific data from its lunar mission orbit. Among these payloads, the LUTI (Lunar Terrain Imager) is the high-resolution camera, developed by the Korea Aerospace Research Institute (KARI), captures various lunar terrains including scientific sites and historical sites. Several Apollo program landing sites are also target points for LUTI. High-resolution images of historical sites, such as those from the Apollo program, were acquired by the Lunar Reconnaissance Orbiter (LRO) operated by the United States. Using these images of Apollo program landing sites, we conducted an analysis to evaluate the geolocation precision of Danuri.

[P-37] Initial Public Release of KPLO SPICE Kernels: Preparation and Follow-Up

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In March 2024, the ancillary data of KPLO, South Korea's first lunar satellite launched on August 5, 2022, was finally released to the public and scientists through KPDS in the form of a SPICE kernel. In preparing the kernels for release, we first finalized the kernel items for release and regenerated the kernels as needed. The SPK kernel, which is the orbit information of the satellite, was improved in accuracy by determining the orbit for a month-long period. The daily CK kernel was merged into the weekly CK kernel. NPB PDS4 Bunlder 1.6.2 distributed by NAIF was used to create bundled kernels in the PDS4 standard for the archive and validated using PDS4 validation tool 3.4.1. The generated bundled kernel was made publicly available through the KPDS website. Based on the evaluation of the initial trial operation results, the directory

structure, file search function, and information viewer function and so on were upgraded to make it easier for the public to access the kernel data. This paper details the procedure for generating the NPB bundled kernels and the results of its operation.

[P-38] Study on Open Data Policy for Scientific Research from Korean Space Explorations

Joo Hyeon Kim

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Public access to scientific data from South Korea's first lunar orbiter, Danuri, became available through the KARI Planetary Data System website starting in January 2024. This release aims to enhance scientific and educational achievements by leveraging space exploration data and fostering public interest in research supported by national taxes. However, in Korea, the Open Data Policy for scientific data from space exploration is perceived as insufficient in achieving these objectives, particularly for a newcomer in space exploration.
In this paper, we present domestic and international case studies on Open Data Policy for scientific data and space exploration data. We also explore Korean laws and regulations concerning space-related scientific data. Additionally, we suggest amendments to improve Korean policies to enhance scientific research and educational activities with the scientific data of space explorations.

[P-39] Development Plan of the Thruster Simulator for GEO-KOMPSAT-3 Electric Propulsion System

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The Geosynchronous Earth Orbit-Korea Multi-Purpose Satellite-3 (GEO-KOMPSAT-3) applies an electric propulsion system for North-South Station Keeping(NSSK) operations.
The electric propulsion system for GEO-KOMPSAT-3 comprises six Propulsion Power Units (PPUs) to supply power, six Propellant Management Assemblies (PMAs) to transfer Krypton from the tank to the thrusters, six thrusters, and two tanks.
Since the electric propulsion system can not operate in a general ambient environment other than a vacuum environment, it is necessary to develop a thruster simulator to simulate the characteristics of the thrusters.
The purpose of the thruster simulator is to simulate the electrical properties of the thrusters in the system environment testing of GEO-KOMPSAT-3. The thruster simulator consists of a thruster load, a PMA load, and a thrust sensing load for simulating the HEMPT (High Efficiency Multistage Plasma Thruster).
In this paper, the technical requirements for developing a thruster simulator are described and the testing plans are summarized.

[P-40] Performance Test of the Rolling Sheet Core SCM

Yunho Jang[1], Hyeonji Kang[1], Seungmin Lee[1], Ho Jin[1], Jinsang Kim[2], Ikjoon Chang[2], Ickhyun Song[3], Younghhwan Kwon[2], Taeyeong Kim[3], Khan-Hyuk Kim[1], Minjae Kim[4]

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We are developing a Space Search Coil Magnetometer (SSCM) with a frequency range of 10 Hz to 20 kHz and a Noise Equivalent Magnetic Induction (NEMI) of 10 pT/Hz1/2. The SSCM consists of a 3-axis SSCM module and Search Coil Electronics module (SCE).
The SSCM module has a rolling sheet core and 5 bobbins which has a total 12,000 turns of winding. In this study, we compared the performance of rolling sheet, rod, and stacked sheet cores. As a result, the rolling sheet core has the lightest weight and shows a similar performance to the other cores. We also carried out the output voltages comparison between the rolling sheet and an air core for the basic performance verification. The rolling sheet SSCM module satisfied the requirements by covering a frequency range of 10 Hz to 20 kHz and achieving an NEMI of 0.03 pT/Hz1/2 at 1 kHz.
The 3-axis SSCM engineering model equipped with radiation hardened ASIC devices will be tested at the end of this year. Space environment tests are planned for 2025.

[P-41] Conceptual Design of Pressurized Mobility System Applying ECLSS (Environment Control & Life Support System) for Undersea Platform

Younkyu Kim, Joohee Lee

Korea Aerospace Research Institute

This work presents a conceptual study of a pressurized mobility system, including an ECLSS, for manned exploration of the lunar surface. NASA's lunar exploration program, Artemis, includes ISRU missions and manned missions for sustained and sustainable lunar exploration, where lunar surface mobility systems will play a major role and be utilized. The primary lunar surface mobility missions for ISRU include resource exploration, resource assessment for resource extraction, and resource extraction in single and multi-mission areas of the lunar polar regions. In particular, lunar resource exploration requires heavy-duty mobility systems for ISRU-related resource

production such as water and oxygen, and lunar resource processing missions require heavy-duty mobility systems to support ISRU system infrastructure and facility construction, by-product processing, etc. The resources produced by the ISRU are used in the manned space habitat module, especially water, which is essential for human habitation in the ECLSS system. Water is used to provide oxygen to the astronauts through electrolysis, and is also used for human habitation. The pressurized rover system, including ECLSS, is a system that enables long-term and remote lunar surface exploration by humans. In this study, a conceptual design of the subsystem of a manned rover with a habitation module including the system design of the ECLSS was performed,

[P-42] Performance Analysis of a Configurable Platform Satellite

Jeongheum Im

Korea Aerospace Research Institute

This paper describes the performance analysis of a configurable platform satellite whose main mission objective is to provide the platform for the verification of new domestic space technologies or equipments which have no space heritage yet. System architecture is described first. And then design mission orbit is suggested considering the characteristics of various kinds of candidate payloads, mission life time requirements and IADC space debris mitigation guidelines and so on. General operation concept is designed. Attitude of the satellite during normal operation with respect to the sun is depicted. System phase is identified and the mode transition flow is designed. Each of mode is designed with attitude of the satellite with respect to the sun and the earth. Key performance of the satellite is summarized and allowable payload location is identified. General characteristics of the design mission orbit was described. System mode and attitude control subsystem modes are summarized. Battery sustainability analysis from launch until separation from the launch vehicle on orbit, has been conducted considering on/off configuration of each equipment.

[P-43] Optimization of a High-Speed Digital Fluxgate Magnetometer

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The magnetometer is an essential instrument in space research, Among various types of magnetometers, the fluxgate magnetometer having advantages in high sensitivity with low power consumption has been widely used to detect the low-frequency signal of the magnetic field in conjunction with a search-coil magnetometer which can measure the high-frequency signal. We had tested the high speed readout fluxgate magnetometer which has a measurable frequency that is extended to a few tens of kHz corresponding to a search-coil magnetometer by replacing the analog components with the digital circuit comprising a Field Programming Gate Array (FPGA). FPGA in this fluxgate magnetometer not only generates the driving pulse used to saturate the ferromagnetic core, but also determines the ADC trigger timing where the output signal of the sensing coil maximizes. Employing a pre-amplifier with filters, the output signal is adjusted to fit the input voltage range of the ADC and unwanted noise is eliminated. Furthermore, with a precise clock adjustment of the FPGA, we optimized the ADC trigger pulse timing to maximize the resolution of the magnetometer. In this paper, we present the optimization process of the output signal of the high-speed digital fluxgate magnetometer with an initial performance result.

[P-44] Registration Method for Heterogeneous Vision-Based Sensors in a Robotic Testbed for On-Orbit Servicing Research

Jin-Hyung Kim

Korea Aerospace Research Institute

To perform on-orbit servicing, accurately estimating the attitude of the target object from visual information is essential. In space, the atmosphere is thin and there is no deficiency of certain bands of infrared light caused by ozone, so imaging targets with sensors such as cameras, lidar, and ToF cameras may differ from terrestrial applications. To address these environmental factors, researchers are developing datasets in orbit.

At KARI, we use a robotic testbed to study on-orbit servicing technologies. One of our studies involves estimating the 6DoF pose of a target space object using vision-based sensors. To design and validate the attitude estimation algorithm, we use a mock-up microsatellite, ToF camera, 3D LiDAR, visible camera, and IR-based motion capture system.

To create a ground truth set for the pose estimation algorithm, it is essential to align each sensor. The 2D-3D cameras are aligned using the PNP algorithm, and 3D point clouds are acquired from the ToF camera and 3D LiDAR to align the two sensors. The study proposes an alignment technique for the robot arm and sensor mount, as well as the mock-up satellite, mock-up satellite rotator, and motion capture system. The alignment is performed based on the position relationships of the markers in various postures and rotation states.

The proposed technique was simulated using Matlab and the open-source CloudCompare Software.

[P-45] Case Study on Mechanical Interface for Mounting a Laser Reflector on a Satellite

Jongwon Lee

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The laser retro-reflector array (LRA) is a simple mechanical unit, not an electrical unit. This has an important role in satellites. LRA is the practice of measuring the distance between the surfaces of the Earth and the satellite using laser ranging to precisely measure the satellite's position. So, this LRA has advantage of being able to build an accurate navigation system because it can be mounted on navigation satellite.
For interface between LRA and satelite, field of view (FOV) should be considered because the LRA will be reflect the laser fired from the SLR, So, It should not disrupt the FOV at the mechanical interface with the satellite.
This paper introduces cases of foreign laser reflector development and analyze the mechanical interface between the developed LRA and satellite.

[P-46] Analysis of GN&C Subsystem Development Case Studies for Domestic On-Orbit Servicing Mission Design

Yoon-Jeong Jang

Korea Aerospace Research Institute

On-Orbit Servicing (OOS) is a service that provides status inspection/repair/replacement/upgrade, orbit and attitude maintenance, refueling, space debris removal, and parts replacement for artificial objects flying in orbit of space. Among OOS technologies, the most representative requirements for a Guidance, Navigation, and Control (GN&C) functions are precision/stability, and increasing these is a high priority. To this end, this paper investigates existing GN&C subsystem technologies based on object detection, hazard and collision avoidance for application of OOS concepts. Currently, Korea Aerospace Research Institute (KARI) is researching and developing OOS missions and related technologies, and in order to apply them, it is necessary to analyze related subsystem development cases overseas. In addition, it is important to closely examine the applicable scope and measures when developing domestic missions and system designs.

[P-47] Latitudinal and Longitudinal Asymmetries of the Lunar Surface Evolution on Lunar Crater Walls

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Lunar regolith undergoes maturation through space weathering and refreshment through impact gardening simultaneously. Space weathering on the Moon is primarily caused by solar wind particles and micrometeorites, while impact gardening arises from meteoroids and interplanetary dust particles incident to the surface. In the present work, we measured the latitudinal and longitudinal trends of flux variation with wall quadrants of ~27,000 lunar craters, distributed across latitudes within ± 50°. Through detailed analysis using a large number of craters, we discovered a latitudinal asymmetry and a distinct longitudinal offset between the northern and southern hemispheres. These results trace evidence of impact gardening caused by meteoroids. We suggest that the observations can be understood with a simple model integrated with space weathering by solar wind particles and impact gardening by meteoroids.

[P-48] Design, Manufacturing and Performance Verification of the Local Shroud for the Thermal Vacuum Test of CAP-W Payload of CAS-4 Satellite

Dae-Jun Jung, Sang-Gyu Lee

Korea Aerospace Research Institute

The CAP-W (Compact Advanced Payload with Wide Swath) is an electro-optics camera that is installed on the CAS-4 (Compact Advanced Satellite-4) satellite. The CAP-W payload is equipped with five multispectral channels and has the capability to capture images with a wide range of swath width. The payload is specifically designed to capture images related to national agriculture, water resources, and forests.
In order to verify the performance of the CAP-W payload, a comprehensive set of in-orbit environment tests are planned, including vibration and thermal vacuum tests. The thermal vacuum test simulates the extreme temperature and pressure conditions of space and evaluates the payload's performance under these conditions.
The MTF test measures the capability of the payload to transfer spatial information from the object being imaged to the image captured by the sensor. It is a critical factor that determines the sharpness and clarity of the images captured by the payload. The MTF test is performed under thermal vacuum conditions to simulate the extreme temperature and pressure conditions of space and ensure that the payload's performance is consistent even under these conditions.
In this paper, we outline the design of local shroud for temperature control in vacuum chamber, manufacturing process and performance verification by blank test of local shroud itself.

[P-49] Launch Vehicle Electrical Interface Summary of the Second Korean SAR Satellite with Multi-Mode Operations

Hong Won Park
Korea Aerospace Research Institute

This paper presents the detailed electrical interfaces between launch vehicle and the next Korean SAR satellite with multi-mode operations.
The SAR satellite have two payloads where the primary is the SAR payload with a high resolution imaging radar and the secondary is the spaceborne AIS payload. Currently, the launch is scheduled for early next year on the Vega-C launch vehicle from the CSG (French Guiana) and the carrying structure called as VESPA+R for dual launch is in development.
According to the heritage program, the electrical interfaces between the spacecraft and the Vega-C launcher are connected via two separation connectors for EGSE and LV MUX telemetry system. However, it is mutually agreed that the LV MUX simulator instead of LV MUX system will be used to monitor the spacecraft telemetry in launch pad just before launch. Therefore, the channel characteristics between the satellite and the LV MUX simulator was modified due to the harness length unlike before. The electrical interface checkouts are being planned to be verified progressively depending the test location and test configuration.
As a result, the detailed electrical interfaces of the next Korean SAR satellite is summarized and the test sequences are presented for the successful launch preparation.

[P-50] Weighted-Average Channel-Offset Correction Method Using Overscan Pixels in Satellite Electro-Optical Camera

Youngsun Kim, Haeng-Pal Heo
Korea Aerospace Research Institute

Offset exists necessarily in the digital outputs in the photodetector used for satellite camera due to the output port circuit itself and the pixel dark current from thermal effects. This offset reduces the dynamic range which is one of most important performance index in the satellite electro-optical camera. This paper shows the method to remove it applying weighed average from the detector overscan pixels. The actual offset can be calculated as the weighed average from overscan pixels at each line. The weight for calculation can varies with the camera system. It usually needs hundreds of lines of stabilization time from beginning which is not long time for the general satellite camera application. The paper verifies the proposed correction method by simulating the active pixels and overscan pixels in accordance with actual detector characteristics for satellite camera.

[P-51] 3 Years Operation Progress of CAS500-1 Satellite in Orbit

Jong-Oh Park, Ok-Chul Jung
Korea Aerospace Research Institute

The CAS500-1 is a 500 kg-class satellite for national territory management, agriculture and forestry management, disaster monitoring & control, Korean peninsula observation etc.
The CAS500-1 satellite was launched by Soyuz launcher on March 22, 2021.
In this paper, I will introduce the orbit operation progress of CAS500-1 Satellite such as fuel level, orbit characteristics, image collections and receiving during 3 years after launch.

[P-52] Operation and Performance of GPS Receiver during Launch and Early Orbit Phase in LEO

Sanggoo Kim, Kiho Kwon
Korea Aerospace Research Institute

After a satellite is launched and successfully reaches on orbit, the satellite automatically initiates On-Board Computer, deploys solar panels, and stabilizes its attitude. Traditionally, if ranging is available to acquire accurate distance measurement, it is performed before activating GPS receiver because it is possbie to know distance immediatly. Recently, however, GPS receiver activates to obtain satellite location, velocity, and time data without raging after stabilization of satellite. In this paper, we explain the stabilization operations after GPS activation and investigates performance of test maneuver for orbit maintenance during Launch and Early Orbit Phase (LEOP) in Low Erath Orbit (LEO).

[P-53] Spatial Resolution and Its Applicable Understanding on SAR Satellite Image

Jae-Min Shin
Korea Aerospace Research Institute

Spatial resolution is the important performance figure in order to analyze observed targets. Especially in optical images, to identify a interesting target depends on resolvable capability spatially. In SAR images formed by RADAR signals, the characteristic to resolve signals is different from that in optical images. In oder to be applied to a specific application, its pros and cons related to characteristics should be considered. for example, frequency band, speckles, polarizations, reflections, resolvable ability, and so on. It means the concept limited for general optical images does not need for various SAR applications. Therefore, a view point approach to a specific objective should be sophisticated hopefully. Especailly, speckle is not the disadvantage as weakness but the advantage as strength. speckle is caused by diffraction, which comes from

surface reflections on the object. It is just physical characteristic to define itself on reality. In case of object characteristics, specular and diffuse reflection gives information of surface smoothness. Consequently, the means should be used for the exact objective for various applications.

[P-54] A Study on the Topology of Power Processing Unit in Electric Propulsion System

Jae-Dong Choi, Keunjoo Park, Hyoungyoll Jun

Korea Aerospace Research Institute

The satellite's electric propulsion system utilizes the electrical energy from the satellite's power supply for propulsion. Compared to traditional chemical propulsion systems, electric propulsion offers advantages such as higher intrinsic impulse and longer operational life. These electric propulsion systems are typically comprised of three components: a power processing unit (PPU), a propellant storage and supply system, and an electric propellant. Among these components, the power processing unit is responsible for generating, maintaining, and accelerating plasma to the thruster's anode, as well as providing power to the heater, cathode, and series-connected the keeper. The implementation of such electric propulsion systems necessitates additional considerations when designing satellite power processing units due to increased power demands and higher requirements for output power and bus stability. In this study, the latest technological trends of the power topology used in the power processing unit of the electric propulsion system with these characteristics and various applied typologies were presented, and their characteristics were compared and analyzed.

[P-55] Optimizing Satellite Communication Scheduling: A Dual-Algorithm Approach for Efficient Ground Station Utilization

Jae-Gyu Kim[1], Geun-Seok Song[1], Young-Hwan Kwon[1], Yeong-il Kim[1], Sun-Ju Park[2]

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The advancement of technology has led to an increase in the number of Nano-Satellites, along with the presence of medium to large LEO (Low Earth Orbit) Satellites. This has resulted in a critical issue due to the limited number of ground stations and antennas. These constraints highlight the necessity for efficient Contact Scheduling between satellites and ground stations. The aim of this research is to develop an optimal scheduling decision logic. To achieve this, our approach includes the design and development of two algorithms: an OA (Ordered Algorithm), which prioritizes satellites and ground station antennas, and a CA (Competition Algorithm), which considers additional factors such as the assignment of schedules in previous passes and the duration length. This paper aims to briefly introduce these methodologies and emphasize the ongoing research efforts to improve the determine process for optimal satellite communication scheduling.

[P-56] Analysis of the Effectiveness of Space Object Collision Avoidance through Nano-Satellite Attitude Maneuver

Jae-Dong Seong, Okchul Jung, Youeyun Jung, Sae-Han Song

Korea Aerospace Research Institute

This study analyzed the effectiveness of orbital change through attitude change in nano-satellites operating in low Earth orbit (LEO) without thrusters, focusing on collision avoidance maneuvers. The results revealed that changes in the satellite's cross-sectional area significantly impact its in-track direction, influenced by the aspect ratio of cross-sectional area change and mission altitude. Notably, satellites at lower altitudes demonstrated significant reduction in collision risks with a small amount of attitude change. Through this study, it is judged that the changing the cross-sectional area through attitude maneuver is a sufficiently suitable method in the operation of nano-satellites without thrusters, and is expected to contribute to improving the safety of satellite operations in the New Space era.

[P-57] A Study on Vulnerabilities in Satellite Flight Software

Hyun-Kyu Shin

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In most communication systems, security is a crucial characteristic and requirement. However, satellite system designers, including flight software developers, have tended not to pay much attention to this, relying instead on a strategy of "security through obscurity." In today's active and widespread space development, this approach is very dangerous. As the "hack-a-sat" competition demonstrates, the field of hacking has expanded to space, including satellites, and hacking into satellites is actually possible even when communication is protected by encryption. Recent studies have shown that satellite projects using open source software such as cFS have significant security vulnerabilities. Some papers have reported that it is possible to render satellite systems useless by sending malicious commands. This paper introduces recent research on vulnerabilities in satellite flight software and seeks to determine how to detect and handle them.

[P-58] A Study on Thermal Vacuum Test Method for Multi-Satellites

Ji-Seok Kim

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With the advent of the New Space era, there has been a significant increase in demand for satellite launch and operations, driven by the reduction in launch costs and miniaturization of satellite components. As the demand for satellite development grows, the missions of satellites are gradually diversifying, leading to increased attempts to apply various payload types. It have resulted in an increase in satellite envrionment test. However, there is a recent problem of delays in conducting thermal vacuum tests, particularly due to limitations in satellite test facilities. In this study, a method for thermal vacuum test of multi-satellites is proposed. The aim is to efficiently and economically conduct thermal vacuum tests in parallel on multiple satellites. Thermal vacuum tests are typically conducted within a cylindrical chamber surrounded by a temperature-controllable shroud. The chamber's interior simulates a vacuum environment, akin to space, where only radiative heat transfer influences the derivation of the satellite's temperature. Depending on the satellite's size and installation location, the radiative energy emitted and absorbed by the shroud varies. By considering the view factor and performing calculations, the satellite's temperature can be determined. A general method has been established to calculate the satellite temperature within the thermal vacuum chamber, allowing for the application of satellite size, position, distance, and chamber size as variables. Formulas for calculating the satellite temperature based on these variables have been developed, with criteria set at a temperature deviation of 3℃ or less for each temperature reference point. It was calculated and simulated based on virtual satellites. And it will be verified as an experiment through an actual thermal vacuum chamber in the future.

[P-59] Development of an Educational Nanosatellite Avionics Module for NASA's Open Source cFS Framework

Jun-Hyeon Kim, Seung-Jun Oh, Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

Nanosatellites have been gaining attraction in the space sector due to their inexpensive cost and fast manufacture time. Despite their advantages, nanosatellites require specific skills and expertise to develop and implement. However, there is currently no particular nanosatellite platform that students can use for educational purposes. To address these issues, essential avionics for nanosatellites have been developed and evaluated in this work. The avionics for the nanosatellite developed in this study include an on-board computer (OBC) based on the Raspberry Pi CM4, a power management board with the stm32f103 chip, and a communication board with UHF Rx and Tx capabilities. The developed avionics module complies with the PC 104 standard and is designed to run NASA's cFS flight software, potentially increasing the manufacturing accessibility and cost-effectiveness of nanosatellites for educational purposes. The main difference between the avionics module developed in this work and the module consisting of space EM-class avionics was the cross-compilation tool chain. Aside from the cross-compiling tool chain, we found that identical command and control processes can be performed on the cFS flight software using the avionics module developed in this work.

[P-60] Preliminary Structural Design of the Cosmic Pulsating Nano-Satellite

Seung-Jun Oh, Jun-Hyeon Kim, Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

The Cosmic Pulsating Nano-Satellite (CPSat), a 3U-sized satellite, has been selected as a candidate for launch in the '2022 National CubeSat Contest'. The goal of this study is to analyze and validate the structural stability and robustness of CPSat during the launch process using numerical analysis. To that purpose, this study focuses on structural preliminary design verification, including the assembly procedure required for constructing the modular CPSat satellite system. Furthermore, Ansys Workbench was used to perform quasi-static, modal, and random vibration assessments. The assessments were carried out in compliance with GSFC-STD-7000 requirements. The results obtained from numerical assessments clearly demonstrated that the natural frequency of CPSat Structure was higher than 100 Hz, and the M.O.S. (Margin of Safety) estimated was larger than one, demonstrating that the designed structure was robust and reliable, meeting the structural requirements.

[P-61] Analysis for Time Synchronization to Improve Position Accuracy in Low-Orbit Satellites

Jin-Hyuck Kim, Jin-Ho Lee

Korea Aerospace Research Institute

Satellites provide a variety of data indicating time and location to the ground. In order to accurately match the time between these data, analysis such as the measurement time, processing time, and the time collected by the on-board at each sensor is required based on absolute time. In this paper, we studied the analysis of time according to a series of processing processes from sensors to data collection.

[P-62] Conceptual Design of the Cube Satellite CNU Laser Unity Bus (CLUB) for Ground-Space

Laser Applications

Chae-Ryeong Kim, Yang-Ha Ju, Seok-Min Song, Yu Yi

Chungnam National University

We introduce the concept of the CubeSat called CLUB (Chungnam national university Laser Unity Bus), designed to offer an integrated infrastructure for diverse ground-space laser applications. With the advent of the new space era, the rapid expansion of space utilization has begun to reveal the limitations of conventional radio frequencies. As space missions diversify, lasers are garnering attention as a viable alternative. However, laser used between the ground and space are significantly influenced by the Earth's atmosphere. Consequently, understanding the atmospheric effects on laser propagation is crucial. In particular, atmospheric turbulence, which refracts and distorts laser beams, intensifies closer to the Earth's surface, exerting a greater impact on the uplink than on the downlink. While downlink verification is facilitated by ground detection, verifying the uplink poses challenges due to the necessity of space-based detection. In response to these challenges, we propose the idea of CubeSat as a means to enhance understanding and verification of laser propagation in the uplink. Additionally, we present the results of conceptional design by analyzing requirements, focusing on mission design of the CLUB CubeSat, following the stages of systems engineering for systematic CubeSat development.

[P-63] Analysis of Occurrence Correlation of Sporadic E-Layer and Development of Baseline Model

Kyu-Cheol Choi[1], Dae-Kyu Shin[1], Seung-Jun Oh[1], Yong-Ha Kim[2], Won-Hyeong Lee[3]

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Sporadic E (Es) represents a thin layer of enhanced electron density in the ionospheric E region. The electron density at Es is 2–3 times greater than that of surrounding and even reaches to $10^{12}m^{-3}$. The Es layer has a thickness of about 1–2 km and its horizontal length is tens to hundreds of km. The Es is a major factor influencing radio wave in the HF and VHF bands. In order to develop a prediction model for the occurrence of the Sporadic E layer, the correlation analysis was performed with the change in the incidence rate of ES according to solar activity and VIC. The occurrence of ES is higher in the summer months, and the solar minimums tend to be higher than the maximums. If the geomagnetic index is 4 or higher, the incidence of ES is higher in the spring and autumn equinoxes and in the summer. At an altitude of 110 km, the highest number of ES was observed, and the correlation of the VIC was the highest at 0.6. It is known that the occurrence of the Sporadic E layer in the Northern Hemisphere is mainly caused by meteor shower metal particles and wind shear in the neutron atmosphere, and based on this, we plan to develop a prediction model for ES occurrence in the future.

[P-64] Solar Cyclic Variation of Solar, Interplanetary and Geomagnetic Parameters

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Oh and Kim (2013) reported that the variation of solar, interplanetary and geomagnetic (SIG) parameters during solar cycles 21–24. They checked the trends of sunspot number, solar magnetic fields, total solar irradiance, solar radio flux, and frequency of solar X-ray flare (solar), interplanetary magnetic field, solar wind and galactic cosmic ray intensity (interplanetary), and Ap index (geomagnetic) parameters. They concluded that most of SIG parameters during the period of the solar cycle 23/24 minimum have the remarkably low values. They suggested that these unprecedented conditions of SIG parameters originate from the weakened solar magnetic fields. One solar cycle has passed since the solar minimum of solar cycles cycle 23/24. We present the variation of solar activity during the solar cycles 21–25 by examining the solar cyclic variations of SIG parameters.

[P-65] Developement of an Pc1 Wave Detection Model Based on a U-Net AI Architecture

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Pc1 band (0.2 to 5 Hz) waves are one of the ULF (Ultra-Low Frequency) waves that are usually detected by ground-based magnetometers. The Pc1 waves are well-known to originate from magnetospheric EMIC (Electromagnetic Ion Cyclotron) waves. Visual inspection or automatic wave detection algorithms have been mainly used to detect those waves. However, the methods have problems such as taking a long time or parameters to be changed for each data set. In this study, we introduce a U-Net-based AI model to automatically detect Pc1 waves from ground-based magnetometer data. For training the AI model, we utilized pre-categorized dynamic spectrum images of each day for 11 years from Jan 2010 to Dec 2021 from MSR

(Moshiri; L∼1.59) ground-based search-coil type three-axial magnetometers. This study shows the AI technique can be adeptly applied to delete noise and detect waves from wave dynamic spectrum images.

This work was supported by the SpaceAI project from Korea Astronomy and Space Science Institute (KASI) and Kyoung Hee University (KHU).

[P-66] Classification of Ionograms in the Polar Region by the Vertical Incidence Pulsed Ionospheric Radar at Jang Bogo Station, Antarctica

Junho Back[1,2], Geonhwa Jee[2,3], Hyuck-Jin Kwon[2], Khan-Hyuk Kim[1], Changsup Lee[2,3], Young-Bae Ham[2,3]

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The electron density profile of an ionogram is traditionally estimated using image processing techniques based on the shape of echoes reflected in the ionosphere. Vertical Incidence Pulsed Radar (VIPIR) with Dynasonde, however, uses a 3-D inversion program named NeXtYZ, which estimates the electron density profile through phase analysis of reflected echoes. In this study, we automatically classified ionograms obtained from VIPIR/Dynasonde installed at Jang Bogo Station (JVD) for a 5-year period from 2017 to 2021 to validate the efficiency of the NeXtYZ program. We found that more than 50% of ionograms show a reasonable electron density profile. However, NeXtYZ did not properly calculate electron density profiles under dynamic structures of the polar ionosphere, such as sporadic-E and aurora. The distribution of good profiles depends on magnetic local time and season, which may be attributed to the effects of solar irradiation and electric fields at high latitudes. In future work, we will investigate the reasons behind the frequent occurrence of Es layers during the winter seasons and in the dawn and dusk sectors.

[P-67] Study on the Effect of Coronal Holes to Geomagnetic Disturbances during the Solar Minimum Period of 2018 to 2020

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Coronal holes are observed as dark areas of the solar corona in EUV and soft X-ray. A large portion of the magnetic field anchored in coronal holes are thought to extend from the Sun to the interplanetary space. Such so-called open magnetic fields are crucial in driving high-speed solar wind streams that may eventually cause geomagnetic disturbances as propagating toward the Earth. In this study, we first survey large geomagnetic disturbance events that occurred during the solar minimum period from 2018 to 2020. In order to examine their solar origin, we then examine EUV images obtained by the Atmospheric Imaging Assembly (AIA) onboard the NASA's Solar Dynamics Observatory (SDO). As a result, coronal holes in either equatorial or polar regions of the Sun are found to be located at the central meridian viewed from the Earth at the estimated departure time of the solar wind from the Sun prior to the geomagnetic disturbance events. Using a model of reconstructing the solar global magnetic field, we also confirm that there exist large-scale, open magnetic field lines from coronal holes toward the Earth.

[P-68] Studying Electromagnetic Ion Cyclotron Wave Energy Transfer Using Arase Satellite and Ground-Based Magnetometer Data

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Previous studies have discovered that electromagnetic ion cyclotron (EMIC) waves are generated due to temperature anisotropy by proton cyclotron instability, and they propagate along magnetic field lines to the ionosphere. They trap into the ionospheric duct and propagate transversely to the low L-shell regions through the duct. These waves play a key role in the loss of energetic protons and relativistic electrons in the radiation belt to the ionosphere by pitch-angle scattering so-called EMIC wave-particle interaction, as well as energy transfer during the propagation. In this presentation, we introduce an ongoing project to reveal the scale of energy transfer by EMIC waves from the source region to the ground stations at the lower latitudes. For this study, we used data from the fluxgate magnetometer (MGF) onboard the Arase satellite and four different ground-based induction magnetometers at Magadan (MGD), Moshiri (MSR), Sata (STA), and Bohyunsan (BOH) that cover various L-values from L∼1.22 (STA) to L∼2.89 (MGD). Observing the entire lifetime of the waves will

help us understand propagation characteristics of EMIC waves more furture.
This research was supported by Young Scientist+ Research Program 2023 through the University of Science and Technology (No. 2023YS19).

[P-69] Exploring Solar Source Regions Relevant to the Open Flux Problem

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The open flux problem refers to a large open magnetic flux discrepancy between results obtained by 3-D global solar magnetic field models and in-situ observations in interplanetary space. Models using observed photospheric magnetograms as input show values about 2–4 times lower than those observed at 1 AU. Although many possible causes of the problem have been suggested, yet even where these missing fluxes are oriented remained uncertain. To determine its source on the Sun, we analyzed the difference in open magnetic flux and the characteristics of the Sun over approximately 14 years (2010–2023). Through analysis of the potential field source surface (PFSS) model and near-Earth observations (OMNI 2), we found a moderate positive correlation (c.c.: 0.57) between sunspot numbers and open flux differences. In contrast, the correlation coefficient between sunspot numbers and PFSS-derived open flux was weaker (c.c.: −0.2), indicating a negative correlation. We also analyze relationships between the open flux differences and coronal hole sizes and discuss implications of these results.

[P-70] SpaceAI 2024: An Annual and Collaborative R&D Program for Breaking through Challenges in Space Science and Technology with Artificial Intelligence

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SpaceAI is an annual, collaborative R&D program in which scientists, software engineers, industry experts as well as students/citizens all participate in as various project teams, in order to solve targeted, peer-reviewed questions in space science and technology with artificial intelligence (AI). The program runs in parallel with a scientist track and a citizen scientist track. The scientist track coordinates scientists and AI engineers to voluntarily participate in peer-reviewed projects as team and supports the project teams providing a concentrated co-working environment, motivation, continuous advice and computing resources. The citizen scientist track opens up opportunities for students/citizens to have hands-on training in developing AI models with a variety of datasets used in space science. We welcome any suggestions for maximizing the practical use of this program and encourage your participation. The details and schedule of the SpaceAI 2024 program can be found in the following webpage: https://spaceai.kasi.re.kr.

[P-71] Statistical Study of the Relationship between Pi2 Waves and Aurora Luminosity Observed at Jang Bogo Research Station, Antarctica

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We have statistically studied the relationship between Pi2 (~6.7–25 mHz) waves and luminosity oscillations in discrete aurorae observed at the Jang Bogo station (JBS) (74° 37.4’ S, 164° 12.0’ E), Terra Nova Bay, Antarctica. In the pre-midnight sector, numerous discrete aurorae related to substorm activities appear in the northern sky of the JBS, assumed to be located at the poleward boundary of aurora oval. We observed events with temporal luminosity changes coinciding with the period of high-latitude Pi2 waves at JBS. In this paper, we will discuss the correlation between precipitating electrons and two events: temporal luminosity changes of aurorae and Pi2 waves, as well as the potential source of these oscillations.

[P-72] Characteristics of Auroral Occurrence at Jang Bogo Station, Antarctica

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Jang Bogo Station (JBS) is located at the magnetic latitude of about 79 deg, which is mostly located in the polar cap region. In order to observe the auroral activity over the JBS, we have been operating visible auroral All-Sky Camera (ASC) since 2018. Using the auroral image data from the ASC for 6-year winter period of 2018–2023, we produced auroral occurrence maps to investigate the characteristics of the auroral occurrence over the JBS including its variations with the magnetic activity index (Kp), Interplanetary Magnetic Field (IMF) and solar cycle (F10.7). The produced auroral occurrence maps show that JBS moslty belongs to the polar cap region but becomes close to

the auroral oval during the morning sector in terms of the magnetic local time. In particular, the auroral occurrence maps indicate the JBS seems to be located at the cusp region near the magnetic local noon. The characteristics of the auroral occurrence over the JBS may allow us to investigate the behaviors of the polar cap boundary with the magnetic activity and solar cycle in the magnetic morning and noon local time sectors.

[P-73] System Requirement and Preliminary Structure Design of ECliPSE

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ECliPSE is a balloon gondola that can observe the solar corona at 30 km altitude using a 3-axis attitude stability reaction wheels. For the development of ECliPSE, requirements were established by dividing them into attitude control, thermal control, sun pointing control, laser communication control, and structural design. The sun pointing module and laser communication module were classified as payload, and other structures and parts were classified as bus. Each payloads were designed to weigh within 5 kg (TBD), and the bus was designed to weigh within 20 kg (TBD). This study conducted a preliminary design to determine whether a design that meets the payload requirements was possible. In the case of the sun pointing module, it was designed to satisfy requirements on the spatial and temporal resolution. In the case of the laser communication module, an error angle within 1° (TBD) was considered to enable communication with the ground station, and it was designed to transmit data of 1kB/s (TBD).

[P-74] Magnetic Relaxation Seen in a Rapidly Evolving Light Bridge in a Sunspot

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We report a magnetic relaxation process occurring within a sunspot, coinciding with the development of a transient light bridge (LB). Utilizing high-resolution imaging and spectro-polarimetric data captured by the 1.6 m Goode Solar Telescope at the Big Bear Solar Observatory, we observed the temporal evolution of a rapidly evolving LB. The LB emerges as a consequence of the vigorous intrusion of filamentary structures bearing predominantly horizontal magnetic fields into the vertical umbral fields. Notably, a pronounced current density is identified within a localized area exhibiting rapid alterations in magnetic field topology within the sunspot, particularly at the interface boundary between the LB and the umbra. Furthermore, intermittent and recurrent bright jets are observed in the chromosphere along this region, attributed to magnetic reconnection. During the latter phase of our observation, the horizontal component of the magnetic field within the LB diminishes, leading to the restoration of the typical convective structure within the sunspot, characterized by umbral dots. Our findings offer a comprehensive perspective not only on the evolutionary dynamics of the LB phenomenon itself but also on its ramifications for neighboring regions, encompassing chromospheric activity and the alteration of magnetic energy within a sunspot.

[P-75] Dependence of Solar Proton Event on 3D CME Parameters

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Strong solar proton events (SPEs) are one of the important factors in space weather. They are primarily accelerated by fast and wide coronal mass ejections (CMEs). In this study, we examine the relationships between 35 SPEs and the physical parameters of three dimensional (3D) CMEs during solar cycles 23 and 24. Utilizing the ice-cream cone model, we obtain the 3D CME parameters, which offer more accurate representations of CME characteristics. We analyze the peak fluxes of SPEs with respect to 3D CME speed, angular width (AW), mass, and kinetic energy. The results demonstrate moderate correlations between SPE peak fluxes and speed, as well as AW. Additionally, significant correlations are observed between SPE fluxes and CME mass, along with kinetic energy. Moreover, longitudinal dependencies are found in the correlation of each parameter. It is noted that the 3D CME kinetic energy is an important factor for estimating and predicting SPE characteristics in space weather.

[P-76] Comparison of Solar Flare Detection Results between Deep Learning-Based Object Detection Models: SSD and Faster R-CNN

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We have detected solar flares using two deep learning-based object detection models and compared the results. Representative deep learning-based object detection models, Single Shot MultiBox Detector (SSD) and Faster R-CNN (Faster Region-based Convolutional Neural Network), were used. The dataset for training models are made from solar full disk images of Korean Data Center (KDC) for Solar Dynamics Observatory (SDO) and solar flare lists of the Space Weather Prediction Center. We trained the models using 2010–2017 dataset and the result show that the performance of Faster R-CNN is slightly better than SSD. We plan to automatically detect solar flares and create a catalog using the trained model. We will also open the flare dataset to public on the KDC for SDO website.

[P-77] Retrieval of the Characteristics of Local Thermospheric Winds over the Korean Peninsula

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Obtaining thermospheric wind data is a significant challenge due to the complexity of the thermosphere and limitations in measurement techniques. The Michaelson Interferometer for Global High-resolution Thermospheric Imaging (MIGHTI) on board the Ionospheric Connection Explorer (ICON) satellite measured global thermospheric wind data from December 2019 to November 2022. The data coverage of ICON/MIGHTI winds spans from 10°S to 40°N. Consequently, ICON/MIGHTI provided valuable thermospheric wind data over the Korean Peninsula. Although ICON/MIGHTI detected airglow emissions from both the green (557.7 nm) and red (630.0 nm) lines to estimate thermospheric winds covering altitudes between roughly 90 and 300 km, this study only analyzed the green line emission. The green line emission is detectable during the daytime, but it is not detected at altitudes of about 150 km or more during the nighttime. The Fourier transform technique is well-known as a method to compute tidal components when winds are observed for a sufficient time (20 hours or more). However, the Fourier transform computed inaccurate tidal components since ICON/MIGHTI did not provide wind data during the nighttime. Therefore, we used Extracted-Local Thermospheric (ELT) wind profiles to compute more accurate local tidal components. For computing ELT wind profiles, we extracted local thermospheric wind profiles from the global zonal averaged thermospheric wind profiles over the Korean Peninsula, covering the period from December 2019 to November 2022. We then compared these ELT wind profiles with computed ELT wind profiles derived from the Horizontal Wind Model (HWM14). This study enhances our technique for acquiring local wind data from space-based wind data.

[P-78] How Much Can We Remove the Ambiguity of 3D CME Geometry Determination by Multi-View Observations

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It is difficult to determine a unique three-dimensional structure of a coronal mass ejection (CME) using only a single observation data because the same projected structures are generated from different three-dimensional structures. This problem can be minimized by using multi-view observations. In this study, we test how many three-dimensional structures are reduced using multi-view observations compared to single-view observations. We use synthetic CMEs with the same radial height (r = 16R_s), angular width (α = 90°), and latitude (θ = 75°), but different longitudes (ϕ = 0°, 30°, 60°, and 90°) as the reference CMEs. We generate synthetic CMEs based on a full ice-cream cone model with the projections of the reference CMEs from three viewpoints (L1, L4, and L5). In each viewpoint, we estimate the root mean square (RMS) error between the projected heights of the reference and those of an arbitrary three-dimensional structure. We select the three-dimensional structures with an RMS error of less than at 0.3R_s as the possible solutions of the reference. Then we find the overlapping values in the solutions. The number of solutions at L1 point is 10817 for ϕ = 0°, 2393 for ϕ = 30°, 39 for ϕ = 60°, and 69 for ϕ = 90°, respectively. We find that the multi-view observation pair L5-L1-L4 dramatically reduces the number of solutions, resulting in a unique solution for every longitude.

[P-79] Strong Solar Radio Burst Observed by eCALLISTO in KASI

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The eCALLISTO is a global network of frequency-agile solar radio spectrometers. One of them was installed at KASI and has been operated since 2007. The eCALLISTO aim to monitor solar radio burst and produce the data in the frequency ranges from 45 MHz to 450 MHz. In the poster, we present strong solar radio bursts obtained by the eCALLISTO of KASI. The radio burst was associated with X2.5 flare occurred in 2024 Feb. 16 and the flare accomponied a partial CME. For the study, we used multi-wavelength EUV imaging data obtained by AIA onborad SDO (Solar Dynamics Observatory). Based on

the results, we will suggest which physical phenomena in the low corona are relevant to the radio bursts.

[P-80] Establishment of Requirements and Initial Design for ECliPSE (Experiment Corona Using baLloon Radiosonde Pointing Sun Essential) Thermal Control

Gybum Kim[1], Hojin Lee[2,3], Ji Eun Choi[2], Chae Yoon Kim[1], Min Hyeok Jeong[1], Won Ki Du[1], Heesu Yang[2]

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ECliPSE is a project developing a prototype of a balloon gondola intended target altitude of 30 km. Taking into account temperatures of −70℃ and pressures of 3.75 torr at this altitude, we designed the gondola's thermal control system considering both internal heat dissipation and solar radiation. We determined the size of the passive radiation cooling plate required to maintain operational temperatures. This presentation will introduce our parametric calculations and the conceptual design of the thermal control system.

[P-81] Study of the Geomagnetic Disturbance during the Solar Minimum Period

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Solar activity is the major factor that affects the space environment, including the magnetosphere and ionosphere. In this study, we focused on strong geomagnetic disturbances occurring during the solar minimum period. All events were accompanied by strong substorm. 97% of events had strong substorms observed with weak and moderate geomagnetic storms. However, only 3% of events occurred simultaneously as strong geomagnetic storm and, among them, 2 events were associated with ICMEs (interplanetary coronal mass ejections). We will introduce the solar wind conditions during events and discuss what could have led to the occurrence of geomagnetic storms and substorms during the solar minimum period.

[P-82] Frequency Coordination Activities for Earth Stations in Geostationary Satellite Programs

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Frequency coordination activities in satellite programs include not only coordination activities between satellite networks, but also between the Earth stations of a satellite network and any existing adjacent terrestrial networks. As coordination activities for Earth stations involve frequencies used by terrestrial networks which are managed by corresponding administrations, coordination is implemented at the administration level either through national administration level meetings or the exchange of correspondence letters. This paper will look at the regulatory and technical factors regarding the coordination activities for Earth stations. A comprehensive insight of such activities will provide a better understanding of the less noticed but essential step of acquiring frequency resources for Earth stations in geostationary satellite programs.

[P-83] Standard Procedure for Selecting a Satellite Launch Vehicle Considering Various Situations

Eungsik Park, Wonsuk Lee, Jonghwi Choi

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Satellite manufacturers usually sign and manage a contract with launch service providers for the launch of satellites. This paper introduces the standard procedures, including principles, selection process (whether it is competitive bid or not), and evaluation method for selecting a launch service provider with its launch vehicle. In particular, various technical, commercial and political risks that may arise during the contract implementation process, such as war, international sanctions, and technical difficulties, are considered and evaluation measures for newly developed and improved launch vehicles together with existing launch vehicles are described.

[P-84] Management Strategies for Multi-Agency R&D Projects

Ji-Mo Yang, Keun-Woong Shin, Eung-Sik Park

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The multi-agency R&D projects refer to national research and development projects jointly planned, executed, managed, and evaluated by two or more relevant central administrative agencies throughout the entire cycle. The development project of the Geo-Kompsat-3, initiated in 2021 by four ministries, is currently underway. This study aims to examine the approach of multi-agency R&D projects in the development of the geostationary public integrated communication satellite and explore the basis for the implementation and management of multi-agency joint projects after the enactment of the National Research and Development Innovation Act. Multi-agency R&D projects are classified into multi-agency joint projects and department-led collaborative projects according to their planning methods, and additional classifications, such as problem-solving

oriented projects, can also be made based on the planning method. The purpose of multi-agency R&D projects is to prevent duplicate investments, enhance the efficiency of research and development investments, and promote cooperative research among ministries.

[P-85] Launch Status of CAS500 Satellite Series

Keun-Woong Shin, Ji-Mo Yang, Jong-Hwi Choi, Dong-In Han, Eung-Sik Park

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Developed by the Korea Aerospace Research Institute (KARI), CAS500-1 is currently in its fourth year of operation after a successful launch on March 22, 2021, from the Baikonur Cosmodrome in Kazakhstan. Korea Aerospace Industries, ltd (KAI) is overseeing the development of the subsequent CAS500 satellite series (CAS500-2, 3, 4, and 5) utilizing technology transferred from KARI. KARI provides technical management and supervision for the development of the system and bus department of satellite to ensure the success of the industry-led satellite development. In addition, KARI, Korea Astronomy & Space Science Institute (KASI), Hallim University, and KAIST are participating to develop payloads suitable for each satellite's mission. CAS500-2 and CAS500-4 are planned to be launched together in 2025 on SpaceX's Falcon-9 launch vehicle, while CAS500-3 will be launched on the fourth launch of KSLV-II (Nuri). For CAS500-5, the specific launch plan has not yet been finalized, but it is expected that the possibility of launching using KSLV-II as well as overseas launch vehicles can be examined. This study briefly introduces the launch status of the CAS500 satellite series.

[P-86] Observational Tools with Nam Byeong-Cheol's Armillary Sphere

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After the introduction of 19th-century Western science in the late Joseon period, Nam Byung-cheol appears to have enhanced an armillary sphere by integrating a new ring known as Jaegeuk-Gwon (a pole-loading ring, 載極環) into the existing three-layer structure. He wrote a book, Uigi-jipseol『儀器輯說』which provides comprehensive instructions on the fabrication, utilization, and calculation methodologies associated with this instrument. We analyzed several observational tools joined within Nam's armillary sphere based on prior researchs. The Tonggwang-Pyo (a light-passing plate, 通光表), Cheuksung-Pyo (a star-measuring plate, 測星表), Jikseon-Pyo (a straight-line plate, 直線表), and Jisido-Pyo (a time-indicating plate, 指時度表) are covered in this study related to its structure and applications. Of 33 total astronomical observations, Tonggwang-Pyo and the Cheuksung-Pyo are used six and five times, respectively. Jikseon-Pyo and Jisido-Pyo were utilized three times each. The observational tools of the 'Nam Byeong-cheol Armillary Sphere' and its application to the astronomical observation before the age of the telescoopes will be presented in this study.

[P-87] Estimation of Zernike Coefficients in Polygonal Optical Mirror Using Machine Learning

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The surface figure error (SFE) of a mirror measured with an interferometer includes alignment errors occurring during the measurement process. Therefore, to effectively analyze the performance of optical systems, low-order aberrations including piston, tip, tilt, and defocus need to be removed. Typically, for optical components such as lenses or mirrors, which are circular in shape, these components are removed by applying Zernike polynomial fitting, decomposing them into an orthogonal basis set on a unit circle. However, in the case of mirrors fabricated with polygons, the orthogonality of Zernike polynomials may not be maintained over the polygonal surface, making it difficult to accurately represent the SFE. In this study, a machine learning-based Zernike coefficient estimation method is proposed. The proposed method takes as input image data of polygonal mirrors measured with an interferometer and outputs 36th-order Zernike coefficients through processing with a multilayer neural network structure. Experimental results using data obtained from actual polygonal mirrors demonstrated that using the proposed method effectively removed low-order aberrations and maintained a low RMS value for residual SFE.

[P-88] Development of a Small Slit Spectroscope for Observing Jupiter Using a 3D Printer

Seungye Lee[1], Seungmo Hong[1], Heesu Yang[2]

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We designed and developed a small spectroscope to spectrally observe methane lines located at 620 nm, 700 nm, and 725 nm on Jupiter. The optical values of Jupiter, the object of observation, were calculated, and a 600 groove diffraction grating, a 50 μm

wide slit, and a Raspberry Pi HQ camera were used as small spectroscope components. The optical design of the spectrometer was reviewed by inputting the calculated optical values and the specifications of each component into the Zemax program.
Based on the reviewed optical design, a spectroscope was designed using the Inventor program, printed using a 3D printer, and assembled.
The spectroscope was printed in three parts: top, main body, and bottom. What differentiates our spectroscope is that a device that allows focus adjustment between the lens and CCD even after assembly is installed on the top panel.
Because the 3D printer was printed using resin, it was printed without precision and it was difficult to find small objects such as Jupiter, but it was confirmed that the spectrum was accurately observed.
It can be expected that a wider variety of subjects can be observed by compensating for the shortcomings identified in this study.

[P-89] Analysis of Various Conditions for Undersea Platform Utilization of Space Life Support System

Joohee Lee, Younkyu Kim, Jongwon Lee,
Ikhyun Choi, Gihyuk Choi

Korea Aerospace Research Institute

Life support systems for undersea platform and space-based life support systems are very similar in terms of functionality. Life support systems used for manned space exploration, such as the habitation module of the International Space Station, are 1 atm inside the module and 0 atm outside. So hydrogen generated by water electrolysis can be easily expelled to the outside of the module. However, in the case of a life support system used for an undersea platform, there is a difference of 1 atm inside the platform and 3 atm outside when considering the environment of 30m below sea level. Therefore, a special method is needed to expel hydrogen to the outside generated by water electrolysis. As such, there are many similar but different considerations for the utilization of space and underwater. These various conditions were analyzed in this paper.

[P-90] Overview of Cold-Gas Propulsion Subsystem for SpaceSCANer Mission

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Space SCANeR (Space Satellite Constellation Architecture for New Concept Surveillance and Reconnaissance) is a multi-Cubesats mission developed by KASI since 2023. As the main objective is to demonstrate a new concept for surveillance and reconnaissance, CPS (Cold-Gas Propulsion Subsystem) is essential to control the formation orbits. Since R236fa fuel has low explosion risk, it can be operated safely. In addition, CPS has a system that transmits fuel from the fuel chamber to the vaporization chamber, vaporizes it to generate sufficient pressure, and then ejects it through nozzles. It is also suitable for use in CubeSat due to its small size, light weight, and low power consumption. We give an overview of CPS for the SpaceSCANer and review its feasibility.

분과 소개

우주감시분과

“우주감시분과”는 우주공간의 환경 보호와 감시, 우주위험의 예방 및 대비 등 우주상황인식 및 우주위험감시 분야에 대한 학술활동 및 네트워크 구축을 위하여 설립되었습니다. 본 분과는 한국천문연구원 박장현 회원을 초대 분과장으로 하여 2018년에 시작되었고, 한국천문연구원 최은정 회원이 2021~2022년 분과장을 맡아 활동하였습니다. 현재 KAIST 안재명 회원이 2023~2024년 분과장을 맡고 있고, 한국항공대학교 이동헌 회원이 간사를, ㈜솔탑 강병국 회원, 한국천문연구원 김명진 회원, 세종대학교 김은희 회원, 한국항공우주연구원 성재동 회원, 한국천문연구원 최진 회원이 운영위원으로 활동 중입니다.

우주감시분과에서는 매년 우주과학회 봄/가을 학술 대회에서 우주감시 Organized Session과 우주감시분과 워크숍을 개최하며, 해당 분야 연구 정보 공유와 저변 확대를 위해 노력하고 있습니다.

우주감시분과에서는 학계, 산업계, 연구기관, 그리고 군에 소속된 80여 명의 회원들이 적극적으로 활동 중입니다. 관심 있는 회원님들의 많은 참여를 기대합니다.



우주관측기기분과

■ 소개

우주관측기기분과는 천문우주관측기기 관련 연구 활동을 증대하기 위해 2018년 5월 봄학술대회 때 창립총회를 거쳐 탄생하였습니다. 당시 47명의 회원으로 한국천문연구원 문봉곤 책임연구원을 초대 분과장으로 선출하였고, 또한 2기 분과장으로 재임하였습니다. 2022년 10월에 3기 분과장으로 한국천문연구원 한정열 책임연구원이 새로 취임하였습니다. 우리 분과는 한국천문학회 천문관측기기분과와 공동으로 매년 천문우주관측기기 워크숍을 개최하고 있습니다. 이를 통해 광학, 광기계, 전자, 제어 소프트웨어, 시스템, 시스템 운영 관리, 데이터 처리 등 다양한 분야의 연구자 간 교류 및 대학 · 대학원 학생의 참여의 기회를 지속적으로 유도하고 있습니다. 아울러 우주관측기기의 국제적인 이슈를 논의하고, 이에 대한 학술적인 지원과 정책적 판단의 자료를 공유하고 있습니다.

■ 활동내역

2018년부터 재개한 천문우주관측기기 워크숍이 2023년 13회째 진행되고 있습니다. 2023년 행사는 한국천문학회 천문관측기기분과의 임원이 중심이 되고, 한국우주과학회 우주관측기기분과의 임원과 함께 조직위원회를 구성하였습니다. 2023년 천문우주관측기기 워크숍은 2일간 7개의 발표 세션에서 총 108명의 참석자가 모여 33개의 구두발표와 5개의 포스터발표가 있었습니다. 메타스페이스, 그린광학, 레오스페이스, 스페이스빔, SM테크, 와이엔디케이, 에이디솔루션 등 7개 패밀리 기업이 참가하고, 22명의 천문우주학 및 관측기기 관련 대학교 학부생 참가를 지원했습니다.

■ 계획

2024년에는 한국우주과학회 우주관측기기분과가 주도하는 천문우주관측기기 워크숍에 공동 주관을 맡아 진행합니다. 아울러 우리 분과는 SPIE (The International Society for Optics and Photonics) 국제 컨퍼런스의 국내 유치를 준비하고 있습니다.



2023 천문우주관측기기 워크숍 단체기념촬영





개회사(좌) 및 축사(우)




발표장 모습





등록데스크 및 기업 부스

우주탐사분과

달 탐사를 시작으로 본격적인 우리나라의 우주탐사 시대를 준비하기 위하여 우주탐사 분야 학술교류와 인재양성 및 교육 홍보의 활성화를 위한 분과 설립의 필요성이 대두됨에 따라 우주탐사분과가 설립되었습니다.
특히, 2024년에는 정책위원회와 공동으로 "우주정책포럼"의 일환으로 "우주개발과 우주탐사 정책" 특별 세션을 개최하며, 우주탐사와 관련하여 워크샵, 특별세션 등 다양한 교류를 계획하고 있습니다.

1. 활동목표

"우주탐사분과"는 우주탐사 과학임무와 임무데이터의 활용 등 과학분야 연구와 탐사선, 탑재체, 발사체, 지상국의 개발 등 기술분야의 개발을 촉진하고, 성과를 높일 수 있도록 우주탐사 제반 분야의 교류와 논의를 목표로 합니다.

❖ 세부활동 목표

- ➢ 우주탐사 관련 학술모임 및 연구교류
- ➢ 우주탐사 관련 기관 간 협력 및 공동연구 추진
- ➢ 국내 우주탐사 분야 발전계획 논의 및 제안
- ➢ 우주탐사 관련 연구 및 기술의 진흥과 정책수립에 대한 지원과 건의
- ➢ 우주탐사 과학임무 개발과 과학연구 수행에 관한 논의
- ➢ 우주탐사에 관한 국제 공동 과학연구 및 기술개발을 위한 논의

2. 연혁 및 구성 (2024년 3월 기준)

❖ 결성: 2015년 4월

❖ 회원 수: 80명

❖ 분과 문의

- ➢ 우주탐사분과 위원장: 김주현 (한국항공우주연구원, kl0630@kari.re.kr)
- ➢ 우주탐사분과 간 사: 심채경 (한국천문연구원, cksim@kasi.re.kr)

초소형위성분과

초소형위성분과는 지난 2020년 4월 발족한 신생 분과로써, 최초 발기인 40명으로 시작하였다. 초소형위성분과의 설립 배경으로는 뉴스페이스(NewSpace) 시대를 맞이하여 민간을 중심으로 소형위성과 초소형위성 개발이 급증하면서, 국내에서도 초소형위성 개발과 활용을 위한 산·학·연·군·관 관계자들의 구심점이 될 수 있는 분과 활동의 필요성이 대두되면서였다.

초소형위성분과의 설립 목적은 국내 초소형위성 관련 학술 활동을 장려하고, 전문인력들과의 교류의 장을 제공함으로써 연구자 저변 확대 및 네트워크를 강화하고, 이를 통해 초소형위성 개발 기관과의 협력 및 공동연구 추진과 지속가능한 발전 진흥계획을 도출하는 것이다.

초소형위성분과는 매년 춘 · 추계 학술대회 기간 동안 초소형위성 세션을 운영하여 국내 초소형위성 관련 연구성과 발표의 장을 제공하고 있으며, 매년 국내 유일의 '초소형위성 워크샵'을 개최하고 있다.

특히, 분과 활동의 핵심인 '초소형위성 워크샵'은 참석자 규모가 매년 확장하고 있으며, 2023년 400여 명이 참석하여 우주 분야 단일 워크샵으로써는 국내 최대 규모의 행사로 성장하고 있다.

초소형위성분과 초대 분과장은 이유 충남대 교수(전 우주과학회 회장)가 역임하였으며, 김해동 경상국립대 교수(현 우주과학회 부회장)가 2대 분과장으로서 2021년 10월부터 맡고 있다.

초소형위성분과 회원은 현재 100여 명으로 늘어났으며, 국내 초소형위성 관련 저변 확대와 함께 지속적으로 분과의 규모와 역할이 증대될 것으로 기대하고 있다.



태양우주환경분과

태양우주환경분과는 태양-행성간 공간, 자기권, 전리권/고층대기 영역 학술 활동 교류와 협력을 위하여 2015년 설립되었습니다. 학술모임 개최, 관련 기관 간 협력, 국가/국제차원의 태양우주환경 분야의 발전을 위하여 활동하고 있습니다. 분과 회원은 우주과학회 정회원으로 구성되며, 연구자 및 관련 업무자로 현재 약 120명의 회원이 활동하고 있습니다.

2013년 전리권/고층대기 연구자들의 학술 교류 및 협력을 위하여 시작된 워크숍이 2014년부터는 자기권을 포함한 근지구우주환경 워크숍으로 진행되었고, 2022년부터 태양-행성간 공간, 자기권, 전리권/고층대기를 아우르는 태양우주환경분과 워크숍으로 확장되어 연 1회 개최되어 오고 있습니다.

2023년 개최된 튜토리얼 중심의 태양우주환경워크숍이 학생 회원들로부터 좋은 반응을 얻었으며, 이와 함께 여름/겨울 학교의 개최가 제안되었습니다. 이에 따라 자유로운 학술 발표 중심의 워크숍과 튜토리얼 중심의 겨울학교를 함께하는 행사를 올 겨울 개최를 위해 준비하고 있습니다. 또한, 이전에 근지구우주환경 워크숍을 위해 준비된 홈페이지가 태양우주환경분과 홈페이지로 변경되었으며, 이를 수정 및 보완하여 분과 관련 소식 공지 및 워크숍과 여름/겨울학교 발표 자료 등을 공유하고자 분과 홈페이지를 준비하고 있습니다.

학술 교류뿐만 아니라, 국내 여러 기관 연구자들이 함께 공유할 수 있도록 국내 우주환경 자료 보유 현황을 조사하여 2021년 “우주기술과 응용”에 세 편의 논문(국내 우주환경 자료 보유 현황: 태양 · 행성간 공간, 자기권, 전리권/고층대기)을 게재하였습니다. 또한, 태양우주환경에서 자주 쓰이는 영어 용어들의 뜻을 정확히 전달하기 위하여 영어 용어를 한글로 정리하여 회원들과 공유하였습니다.

태양우주환경분과 초대 분과 위원장은 곽영실 회원(한국천문연구원)이 역임하였으며 이후 유광선 회원(한국과학기술원), 오수연 회원(전남대학교), 지건화 회원(극지연구소)에 이어 2024년 1월부터 이진이 회원(경희대학교)이 맡고 있습니다.



워크숍 단체사진

2023 KSSS Honors

학술상



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윤병호(조선대학교)

에스이랩상



송석민(충남대학교)

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